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ABSTRACT

Seven papers making up Track V of the 1989 conference of the Professional Association for the Management of Information Technology in Higher Education (known as CAUSE, an acronym of the association's former name) are presented in this document. The focus of Track V is on telecommunications and networking issues and the papers include: "Networking Ohio Colleges in Support of Statewide Economic and Human Resource Development Strategies" (Richard C. Decker et al.); "Reaching the Promised LAN" (John Bates and Gerry LeClerc); "Potential Impacts of the National Research and Education Network on Research Libraries and the Scholarly Community" (Nancy Allen and James F. Williams II); "National Networking Update: How It Affects Your Institution" (abstract of panel discussion); "Towards Negative Entropy: A Strategic Plan" (William J. Moressi et al.); "Changing World Brings Strategic Changes at Penn State" (Steve H. Updegrove and David L. Phillips); "Phase I of a Comprehensive Approach to the Planning and Design of a Multi-Purpose Fiber-Optic Cabling Plant" (Roger V. Bruszewski). An abstract is provided with most of these papers. (DB)

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Managing Information Technology: Facing the Issues

Proceedings of the 1989 CAUSE National Conference

TRACK V: Telecommunications and Networking Issues

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CAUSE89

Track V
Telecommunications and Networking Issues

Coordinator:
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The user community on campuses today is demanding information resources to be delivered to the desktop. Data will be stored on mainframes, and MIPS will be on the micro. Electronic connectivity is through the network. Presentations in this track focused on such subjects as network management and control; integration of voice, data, video, and image communications; dealing with a multi-vendor environment; making the "right" choice when faced with multimillion-dollar costs, budget limitations, and rapidly changing technology; strategic planning and appropriate organization for telecommunications; the TCP/IP debate and development of OSI standards; micro-mainframe connectivity; accessing external resources (e.g., commercial data bases and supercomputing); distributed data bases; and models combining academic and administrative data networks.

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NETWORKING OHIO COLLEGES IN SUPPORT OF STATEWIDE ECONOMIC AND HUMAN RESOURCE DEVELOPMENT STRATEGIES

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In response to the Governor of Ohio's economic and human resource development strategies, The Ohio Board of Regents created EnterpriseOhio, a statewide network of public two-year colleges (community colleges, technical colleges and university regional campuses), to provide training services to local business and industry.

A rapid, comprehensive and flexible communication system was needed to link the colleges. The Ohio Network for Information Exchange (ONet) was developed by Cuyahoga Community College in cooperation with Systems & Computer Technology Corporation. Based at Cuyahoga Community College, ONet is a specially designed educational computer network whose electronic warehouse of information and educational services assists Ohio colleges in providing customized training to meet high technology needs of business and industry.

INTRODUCTION

The Ohio Network for Information Exchange (ONet) is a state-of-the-art communications network for higher education institutions in the state of Ohio. ONet currently provides a variety of communications network services including electronic mail, bulletin boards and databases to more than sixty colleges and universities. ONet was initially proposed, funded and implemented to meet a state-wide need for electronic information sharing.

In response to a changing state, national and international economy, and the Governor of Ohio's request for support of statewide economic and human resource development strategies, the Ohio Board of Regents challenged Ohio's two-year colleges and universities to take a proactive role in their communities' economic development efforts.

EnterpriseOhio, a statewide network of public two-year colleges (community colleges, technical colleges, and university regional campuses), was created by the Ohio Board of Regents to assist in sharing the best resources available for providing job training and retraining services to business and industry. A rapid, comprehensive and flexible communication system was needed to make this sharing possible. The Ohio Network for Information Exchange was developed to provide that electronic network.

BACKGROUND

Electronic communications for Ohio's two-year college presidents dates back to 1984, when Cuyahoga Community College, in cooperation with the Ohio Technical and Community College Association (OTCCA) established the OTCCA E-Mail Network. This early network was limited to sending and receiving short messages and served only the 23 presidents and the Executive Director of OTCCA.

In 1986, The Ohio Manufacturing Training Group (OMTG), a consortium of six Ohio colleges, recognized the need for the acquisition, development, dissemination and utilization of information to support the state's business and industry training needs.

The OMTG submitted a proposal to the Ohio Board of Regents to develop an enhanced comprehensive state-wide electronic information exchange network to: (1) facilitate sharing of information from projects developed among other groups of

colleges within the two-year college system, (2) support information exchange requirements among the consortia group and all two-year campuses, and (3) create more effective information networking between the two-year college system and other organizational and institutional offices and databases in the State.

IMPLEMENTATION

Following the approval of funding by the Ohio Board of Regents on September 12, 1986, the ONet Steering and Planning Committees were appointed and held their first meetings in October of that year. At these meetings, an organizational structure was confirmed, a project coordinator/manager was appointed and project goals and objectives were approved.

ONet was tested on a pilot basis beginning in November 1986, at which time the Planning Committee and other "pioneers" assisted in testing the communications software and provided direction in the design of the network and its components. The electronic mail component and a demonstration bulletin board were available for pilot testing at that time while a prototype database facility was being developed.

By March, 1987, training sessions were scheduled throughout the state with over 100 persons attending. ONet became operational March 30, 1987 when the 24 users of the OTCCA E-Mail Network were transferred to the Ohio Network for Information Exchange. From that initial small group of users, ONet has grown to over 550 registered users in over 60 colleges, universities and agencies.

ONet is not just another electronic mail system, but a specially designed educational network whose electronic warehouse of information and educational services greatly assists Ohio's two-year and four-year colleges in providing credit and non-credit, customized training to meet local and state high technology needs of business and industry.

ONet was developed as a statewide initiative to serve primarily the two year colleges in Ohio. Today, it has been expanded to serve all public institutions of higher education and is being offered to private two and four-year non-profit educational institutions with plans to make it available to secondary schools in the future.

Partnerships

ONet was supported by, not only Cuyahoga Community College (CCC) as the lead institution and home for the mainframe computer, but also by three private companies; Ohio Bell Communications, IBM and Systems & Computer Technology Corporation (SCT). Ohio Bell and IBM provided support in the first year of development. As a result of a partnership already in place between CCC and SCT to manage CCC's computing facilities, this public/private partnership was extended

through the creation of the National Center for Advancement in Education through Technology (NCAET). The purpose of NCAET is to advance excellence in education through the use of technology and to assist in the development and application of technology at CCC and other educational institutions. One of NCAET's major goals is the development and operation of electronic information exchange networks.

As CCC entered into the consortium to propose ONet, SCT, as part of its contractual responsibility with CCC, contributed extensive efforts in support of the initial development of ONet. Through the NCAET partnership, CCC assumed responsibility for all network communications, logistics and management as well as agreed to provide the necessary mainframe equipment and support. SCT agreed to provide the operational, maintenance and development staff and to assist in marketing ONet outside the state of Ohio.

Governance

Governance of the Ohio Network for Information Exchange was defined in the original proposal to the Ohio Board of Regents. Policy and planning directions are still provided by two committees originally proposed - the ONet Steering and ONet Planning Committees respectively.

The ONet Steering Committee serves as the policy body for the project: establishing priorities, assuring short and long term goals and objectives of the project are accomplished and reviewing and approving proposed project budgets.

In August 1987, the Steering Committee changed the name and focus of the group to more accurately reflect the interests of the members and to expand the membership to include three additional institutions who were involved in manufacturing training activities. The new committee combined the Ohio Manufacturing Training Group with the ONet Steering Committee; thus broadening the scope of the committee to permit involvement in other statewide initiatives, with ONet serving as the communications link for these projects.

The ONet Planning Committee is responsible for network development and implementation planning and schedules and makes recommendations to the ONet Steering Committee for final consideration.

The Chancellor of the Ohio Board of Regents appointed the EnterpriseOhio Executive Committee to serve as an advisory group to the Chancellor. This committee reviews all requests for funding from the Productivity Improvement Challenge Program grants which funds special statewide projects such as ONet, Train-the-Trainer and the Ohio Resource Exchange. The EnterpriseOhio Executive Committee provides overall coordination of these statewide projects and combined efforts of the colleges to meet business and industry training needs.

ON-LINE SERVICES

ONet users access the network with a personal computer, a modem and specially developed communications software which supports auto-dialing the network toll free telephone number and automatically logging on to the network. Once on-line, the user may access all available services from menus. The user can also transfer ASCII or binary files, making it possible to send virtually any type of file, (including spreadsheets and executable files) to other users throughout the network.

The services provided by ONet reinforce the colleges' partnerships with the state and the private sector in supporting and advancing the economic and human resource goals of the State of Ohio.

The most important function of ONet is to provide access to a "storehouse of information" through the database and bulletin board components.

Database Component

The database component permits the storage of, and access to, databases developed and maintained by ONet user groups. The database component permits users to search the data in an easy and efficient manner by searching any identified field for a particular word, partial word, or group of words to retrieve desired information. Developed specifically for ONet, and employing a similar search process for all database access, the database facility is a generic system which can be customized for any database to be stored on the network computers.

ONet not only provides access to databases stored on the computers at Cuyahoga Community College, but will eventually permit linking with databases stored on other computer systems via gateways. The following is a list of databases currently available on ONet.

Institution/Agency Directory lists key staff from over 60 different institutions and agencies.

Training and Services Inventory provides a comprehensive listing of credit and non-credit training courses and services, designed and developed to meet the needs of business and industry.

User ID Directory lists the names, titles, addresses and phone numbers of over 550 users who have access to ONet.

Development of additional databases under consideration includes:

- o Access/Retention database
- o OBOR Taxonomy of colleges, programs and courses

- o Grants database
- o Calendar of Events database
- o Others as defined.

In addition to the database services on ONet, another major source of information is provided by the bulletin board component.

Bulletin Board Component

ONet supports bulletin boards to deliver general bulletins or messages to all network users, or selected information to "special interest groups" (SIG) by offering each SIG its own dedicated bulletin board which can be accessed only by its members.

The bulletin board component currently consists of seven (7) public bulletin boards and several private bulletin boards for SIGs. The ONet bulletin boards are designed as electronic 3 x 5 card postings, limited to ten lines of copy but with the ability to attach a text file of any length for more detailed information on the specific topic. The text files can be read and printed on-line or download to the user's microcomputer. At the time an item is posted on a bulletin board, the user is prompted for an expiration date which will automatically delete the message and accompanying text file on the specific date.

The existing public bulletin boards include:

Ohio Network News Bulletin Board - Announces new ONet services, databases, and facilities, as well as helpful hints on how to use the network's many features.

EnterpriseOhio Bulletin Board - Provides messages about the activities of EnterpriseOhio, OBOR and associated projects.

Calendar of Events Bulletin Board - Lists meetings, seminars, and conferences throughout the state.

General Information Bulletin Board - Contains general items of interest, requests for information, want ads, etc., which do not apply to any of the other bulletin boards.

Awards/Grants Bulletin Board - Lists announcements and sources for available funding for educational projects.

Access/Retention Bulletin Board - Offers current information regarding successful access/retention programs already in place at other institutions as well as information on establishing new programs.

Help Wanted - Includes information on positions available, positions sought and requests for adjunct faculty and staff for special projects.

Electronic Mail Component

ONet offers the standard electronic mail functions of sending and receiving messages. It also offers many expanded mail related services such as; permitting the user to file messages received, generating and automatically storing copies of all messages sent, forwarding messages to other users, replying immediately to messages, editing messages and returning them to the sender, printing messages at the local office printer, sending carbon copies to other users and requesting an automatic acknowledgement when the message is read. There is even an on-line spell checker and thesaurus available.

Users can send messages, documents, and files which vary in length from a few words to a multi-page document. These documents can be composed while on-line with ONet, or can be prepared on a microcomputer using stand-alone word-processing, database or spreadsheet software packages. The documents can then be transferred to the host computer and sent directly to identified user(s) or included in an electronic message.

The user has the ability to send messages or prepared documents to one or more ONet users simultaneously, as well the ability to create and maintain distribution lists to send messages, documents and files to groups of users, such as committee members or project team members. Distribution lists can be created and maintained by one user and easily shared with other members of the distribution list for their use.

OPERATING ENVIRONMENT

The host hardware environment consists of an IBM 4381, Model Group 2 computer system, associated disk and tape drives, an IBM 7171 protocol converter and several other types of communications controllers.

The host software environment consists of the VP/SP5 operating system, under which PROFS 2.2.3 and SQL operate. The PROFS menus and screens were customized to provide consistent response from all function keys and more readable screen displays. All menus rely on PROFS kernels which are called by the menu system. All databases and bulletin boards rely on SQL as the information storage and retrieval system and were designed to compliment the customized PROFS displays.

ONet is accessed through the use of a specially developed communications software package developed by ONet with full on-site support from Systems & Computer Technology Corporation staff. This special communications software permits the

users to access ONet by pressing a single key which dials the telephone number and automatically logs the user onto the network. Users need only enter their private password to gain final access to ONet. Once logged-on to ONet, users have the use of full screen editing and menus for ease of operation and selection of the many functions available. ONet is accessible 24 hours a day, seven days a week.

The communications environment consists of phone service provided by two vendors. Four local dial-up lines are provided by Ohio Bell. Six toll free lines, for use within the state of Ohio, are provided by AT&T. A nationwide toll free number is also provided by AT&T. Error correcting modems capable of responding at 300, 1200 and 2400 baud are attached to each line, and are connected to the IBM 7171.

The end user hardware environment may consist of any IBM PC, IBM AT, IBM PS/2, any compatible MS DOS computer or any Apple Macintosh computer. A Hayes command set compatible modem is required. A compatible printer attached to the microcomputer is also supported.

SUPPORT SERVICES

To effectively and efficiently use a computer network requires a certain level of understanding and skill. Special training classes are offered periodically to help develop the needed understanding of the network and to assist users in developing the necessary skill level. This service is an important part of the overall ONet philosophy to enhance the users' ability to effectively employ the services of the network in the most efficient manner.

Assistance is also available on an ongoing basis. If users experience a problem, they may call HELPDESK at (216) 241-6567, Monday through Friday, from 8:30 am to 5:00 pm. If the issue is not urgent, users may send an ONet message to HELPDESK anytime, 24 hours a day, seven days a week. HELPDESK will respond to the query, either via ONet or, if necessary, by telephone. In addition to HELPDESK, each institution has appointed an ONet Liaison to assist local users with problems, supervise the maintenance of institutional information in the databases and coordinate activities with the ONet staff.

ONet Connection is a monthly publication distributed to ONet users as a regular source of ideas on new and existing network capabilities and suggestions on how to better use the available services. In addition, EnterpriseOhio News, a quarterly publication, was created to inform potential users of the availability of the Ohio Network for Information Exchange and to share information from the Ohio Board of Regents, EnterpriseOhio Executive Committee and supported projects and activities.

A copy of the ONet communications software is given to each new user along with the comprehensive QuickStart instructions which explains the setup and use of the communications software.

A set of 16 Quick Reference Guides, outlining the major functions of ONet and how to perform them, is also provided to every user of the network.

FINANCIAL SUPPORT

ONet's initial development was started through a grant of $100,000 from the OBOR. This represented less than a third of the first nine months' development costs. The remainder of the costs were contributed by CCC and the three companies noted earlier. Since that initial grant, OBOR/EnterpriseOhio has provided additional funding in the amount of $285,000 to help launch ONet during the critical development years while the network builds a strong bases of active users. It is projected ONet will become self-supporting by 1992.

Institutions have made a commitment to use ONet and support the network through assessment of users fees based on connect time. Currently, Ohio users are charged at the rate of $20 per hour ($0.33 per minute). ONet, in cooperation with CCC's Accounts Receivable department developed a billing, invoicing and tracking system to provide accurate records on revenue generated. Institutions are invoiced monthly; each invoice details the active user IDs and connect time for the month.

Currently, there is no installation fee for new users, however, consideration is being given to implementing a new user fee and/or some form of a minimum monthly fee.

FUTURE DIRECTIONS

ONet is a dynamic system which will continue to grow, not only in the number of users, but also in the available services to meet the changing needs of the user groups.

In addition to the already available functions, ONet is planning for future services which will have an even greater impact on the operation of individual institutions. Some added services which are under consideration include:

- Gateways to other networks
- Electronic Computer Conferencing
- Electronic Survey Services
- Articulation Agreement Support
- Electronic Exchange of Student Information

Although ONet was developed to serve institutions in Ohio, through the NCAET partnership, similar network services are being offered to other states to develop independent state networks like ONet with the capability of linking the states into a regional and eventually national network.

BENEFITS

Some of the benefits gained from actively using ONet include:

- Locating available training resources for business and industry to meet training and employment needs.
- Assisting colleges in their efforts to improve the economic development climate of their region.
- Improving communications and supporting information exchange among participating institutions.
- Sharing of valuable resources among institutions and omitting duplication of effort.
- Creating important linkages with colleagues throughout the state through continued use of ONet.
- Sharing information and participating in the development of new applications to meet changing needs.
- Providing a cost effective and time saving communications tool to:
  - Communicate with persons without participating in "phone tag".
  - Access information at the time it is needed.
  - Send and receive messages at any time. (The system is available 24 hours a day, seven days a week.)
  - Access electronic mail, bulletin boards and database information services at the approximate cost of a regular state-wide long distance phone call, but with the potential for more immediate response, timely information, and added services.
  - Electronically transfer a multi-page document to another user or a group of users, immediately, at a fraction of the cost of sending a similar document via Federal Express or U.S. Express Mail and with greater ease and speed and lower cost than sending the same multi-page document to several users through facsimile copy.

MORE INFORMATION

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Reaching the Promised LAN

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McGill University's Management Systems group recently installed PS/2s and a Novell/ArcNet Local Area Network. This paper describes the environment, reviews the installation history, and discusses the problems and successes of the installation, including the uses made of the LAN, and the features most liked and most disliked of the LAN and the PS2s.

Background to McGill

McGill is Canada's oldest chartered university, founded in 1821 by a bequest from James McGill, a wealthy Scottish Canadian fur trader. We have been living off bequests ever since.

McGill is an English language institution in the heart of what is now downtown Montreal. Montreal is primarily French speaking, and our province of Quebec even more so. This provides one of our greatest attractions to out of town students - the ability to "go foreign" and practice a "foreign" language whilst studying in English. It is also one of our greatest problems, since most of our funding comes from the same French speaking provincial government.

We are public in the sense that our funding is mainly provincial, private in that subject to some overall approvals from Quebec we make our own rules and spend our money the way we see fit. We are therefore something of a blend between your private and state universities.

We are medium to large, with a day student headcount of 22,000 (19,000 fte's), and an evening headcount of another 8,000. Despite giving almost all of our courses in English, 26% of our students are French mother tongue.

Academically our major strengths are our professional faculties, particularly Medicine, Law and Engineering, and our strong research track record in all areas. We receive more competitively awarded research grant dollars per full time academic than any other university in Canada.

Organisationally, our strength is in our decentralisation. We have a long tradition of faculty power and "bottom up" decision making. The more perceptive will immediately recognise that potentially this can also be a major weakness, and certainly makes providing campus-wide applications and campus wide standards an interesting challenge.

The other, overwhelming weakness, is our financial position. Our deficit for the current year was originally budgeted for $12 million (US) - it is now expected to be around $6 million due to an improved provincial grant. Our cumulative deficit will be of the order of $50 million (US) at the end of the current year.

This sorry financial picture comes after years of belt tightening, short time summer working, and staff cuts, and is attributable to significant, long term, and self admitted government underfunding of us relative to the other large Quebec universities, and to a provincial policy which has frozen tuition fees at their 1968 levels. A Canadian student at McGill pays $450 (US) for tuition per year, even in Medicine.

Background to Management Systems

Management Systems is a fairly typical administrative systems group, with 35 development staff and 20 operations people who do batch data entry, batch updating and reporting, and give first line support to our administrative network users. We share the university's 3090-180E (vector) with researchers (a growing load since it's largely free time), students (a declining load since free PCs are more fun than free mainframes), and commercial customers (also declining). Our load is naturally growing.

We run MVS/XA, IMS as our main database, TSO/ISPF for development, COBOL, Mark IV and V, and have just installed Adabas, Natural and other Software AG products.

Organisationally we report to the same vice principal as the Computing Centre/Telecommunications group.

But our paper today is to do with how and why we implemented a Local Area Network for all of our development and most of our operations staff.

Objectives of the LAN

All of our developers and most of our operations people have had terminals for several years. Since 1982 we had gradually added a kludge of various PCs, XTs, ATs and clones, as we shall discuss later. When the story opens then we had a mix of ancient terminals and disparate PCs.

One of my goals in proposing the LAN was therefore to simplify this mixed environment. Another, and perhaps the most important, was to turn my development staff on to PC possibilities. Some were already PC enthusiasts - most were not. Most had little concept of what PCs could do - and were doing in the right hands - for administrative computing. I wanted to position my staff so that they both understood desktop computing, and could service the growing demands for PC applications support.

Similarly I wanted to build our experience with LANs, so that we could better support the needs of administrators.

And naturally I wanted to do all this and at the same time im- prove our productivity in the development amd operational areas.

And finally I wanted to regain the initiative we used to have, i.e. to catch up with or (gulp) surpass our power users in the field who were doing great things with PC/LAN technology.

Configuration

The configuration that we selected for our MIS department LAN consisted of industry standard software and hardware, which our Computing Centre had on its approved list of Campus products. For our Network operating system we chose Novell Advanced NetWare 286. We are currently using version 2.12 revision B.

The workstations and servers were provided through our Computer Centre Store, and NetWare was "gen'ed" (installed) on our servers by the technical staff of the Computing Centre.

Our choice of workstation was the IBM PS/2 Model 30 286 with 1 Megabyte of RAM and 1, 1.44 Megabyte diskette drive. We decided against hard disk drives, as we wanted everyone to store files on the network disk. The reason for this was to reduce costs and service problems, and to ensure that files were regularly backed up. Every station was equipped with a model 8513 VGA colour display and a mouse. Altogether there are about 50 workstations.

Each workstation is connected to the LAN using ARCnet interface adapters supplied by Pure Data Inc. in Canada. The cable plant consists of RG62U coaxial cable. ARCnet uses a tree topology, with workstations attaching to branches of the tree using "passive hubs" and the branches connecting to the trunk using "active hubs". Our own operations group did all of the cable and hub installation.

We decided to have 2 network file servers. One is the production machine and the other acts as a print server and backup machine for the first. For these, we selected Everex 386 PC's running at 20 Megahertz and equipped with 4 megabytes of RAM. We used 300 Megabyte CDC fixed disk drives for storage. Each file server is protected against power failures and surges by uninterruptible power supplies (UPS) manufactured by American Power Conversion Inc. For backup we are using a Legacy 150 megabyte tape drive.

Our backup cycle consists of daily copies of all files, a tape made weekly and kept for a month, and two monthly tapes which alternate. We also keep a tape off-site.

Since each of our workstations requires access to our host mainframe systems, our plan was to use the LAN as a path to the mainframe with the addition of a gateway server running a program developed in-house by our Computing Centre staff called Net3270. This would eliminate our need for two cable connections to each PC, and extra communications hardware/software such as IRMA.

We also added a remote dial-in gateway server to our LAN using the Remote2 communication software from Crosstalk communications.

Timetable

The UMS LAN grew out of experience with a smaller LAN set up in 1986 within the department's Information Centre. This LAN was based on ARCnet and NetWare, and connected 4 IBM PC's to an IBM AT file server. The Info Centre staff gained experience with the LAN, and I as manager of the Info Centre felt that this would be a good facility for the entire MIS department. Being a keen PC advocate, my boss the director of UMS, became wired to our tiny network soon after we had it fully "shaken down".

In November 88, I prepared a paper for our annual Managers Retreat proposing a LAN for all of Management Systems (excluding Data Entry which had their own minicomputer based system). A decision was taken to go ahead with the proposal if funding could be secured. A month later we had the final specifications and cost estimate for the network. Luckily, the funds were allocated and work began.

The first step was to expand the existing Info Centre LAN to a subset of the department and gauge how well things went. This would help us gain experience on a smaller scale with the vagaries of equipment acquisition, cable installations, software setup, training, and user reactions. We selected staff ranked as project managers and above as our pilot group. They were all equipped with PC's (many of our other staff were not), and they were the easiest to work with because their computing needs were more PC oriented, and they had more PC experience than our analysts and programmers who worked more with the mainframe.

We held our first training course in December 88, and by January 89 had about a dozen new stations on the LAN. Everything was working pretty well, so in February we began to spread the LAN to all remaining systems and operations staff. We decided to acquire and install PC's in groups of 10, to make it easier to setup the hardware and train staff.

Around this time we upgraded our IBM AT server to an Everex PC. Since more than half of the remaining staff not yet networked had PC's already, these were replaced with substantially better PS/2 models. Others who had terminals, were working with PC's for the very first time. Those staff that had PC's were using their PC's as terminals with IRMA cards. We replaced the IRMA cards into the new PC's. This meant that we had to run two cables to each PC temporarily until our gateway connection (Net3270) was fully operational. ARCnet uses the same type of cable as a 3270, so this made the job easier as we were well experienced with installing this kind of coax.

By April 89 we received our last lot of 10 PC's, and everything was running! We pulled several of our staff off of the IRMA link to the mainframe and tested Net3270. We gradually increased the load to test the performance and reliability of the gateway. We instituted weekly meetings between myself, my backup from the systems staff and our operations people to discuss the ongoing management and operation of the LAN.

There were still a few odds and ends missing or backordered (spare NIU cards, extra RAM, multi-user copies of software), but by May these had come in. By June, the implementation was for all intents and purposes, complete.

Over the summer we installed new modular workstation furniture in the department, and the LAN was a Godsend in allowing us to easily relocate staff both during and after the move. At this time we cut over to Net3270 fully, and ceased using IRMA.

Problems

Although everything is now running very smoothly (I'm amazed at how smoothly actually!), we did have our share of problems getting everything right.

Several items shipped to us were defective or failed soon after installation. Among these were 2 network interface units (adapter cards), 1 colour display, 1 PS/2 system unit, and 1 of the UPS's.

We also encountered another "gotcha" when we discovered that about 50 megabytes of our 300 megabyte drives were unusable after being formatted for NetWare.

Since we had two servers, we wanted both to be "online" so we bridged them to each other. This allows a workstation to access either file server. This proved to be problematic, as we somehow got the addresses of the servers mixed up, and couldn't activate one of them. Not having gen'ed the operating system puts you at a disadvantage at times like this!

Another problem which still haunts us today is RAMCRAM, or the inability to fit everything you want into memory at once. We are shoehorning DOS, NetWare, the mouse driver, NetWare menus, Net3270, and Framework III into 640K. This leaves very little working storage, and sometimes programs interfere with one another. We have reclaimed some extra space by using the LANspace program, and by eliminating Netbios from Net3270.

Cables always seem to present headaches in any network installation. We had are share of difficulties as well with cables being unplugged indiscriminately. Once we finally got everyone trained in terminating unused cables, the problem went away. It's a good idea to physically attach a cable terminator to each cable, with a note explaining its use at the end of every user accessible cable!

Our servers are attached to a multi-building fibre optic local area network running ProNet ("backbone") via a gateway. We had several problems with this connection, but with the ProNet driver software and with noise. Our Computing Centre solved the noise problems, but it took a lot of work. The drivers still do not always initialize correctly. The long term solution to this problem is to replace the ProNet with another network, as our Computing Centre expands this backbone to cover most of the campus.

Another source of problems is attempting to change anything about the LAN during the day. Don't do it! Like the mainframe, it's best to make changes outside of normal working hours.

We encountered several difficulties getting our backup tapes to work reliably. Our first unit, a Genoa tape system, never worked 100% of the time. Fortunately it was planned to replace it from the beginning, and its replacement, a Legacy drive soon took over. It also did not always work! Eventually the problem was determined to be owing to the fact that the PC that it was attached to had 512K of memory. Attached to a 640K machine, it has worked fine ever since.

Trying to find a secure spot to house our servers to protect them from the environment, and curious fingers, has also been difficult for a department always short on space. Right now they are kept in telephone wiring closets, where telephone technicians often have to work - and unplug things! We are planning to move them into lockable cabinets soon.

Some of the software we have is only needed by a single user, but since we don't have hard disks on our PC's (and software often requires a hard disk) we have installed the software on the server. With some packages (e.g Harvard Graphics) the software does not work properly on a network disk.

In the area of human psychology, we hit some difficulty when we switched to the Novell Menus. This is a very nice menu facility, much better than the batch file menus we had used at first, but our users had grown accustomed to the old menus, and took awhile to adjust to the new "user interface".

Recently we discovered that even though we have plenty of free disk space, we have run out of "directory entries" on the file server. This means that we have used up all of the space to enter file and directory names on the NetWare volume. Apparently this can only be changed (increased) by regenerating the operating system, a formidable task I am given to understand. We are living with the problem for now by reallocating files onto another spare volume (lucky we have that) and by careful policing and file maintenance of the bloated volume. The lesson here is to allocate plenty of directory entries when you "gen" the disk volumes. 9,000 entries may sound like a big number, but you'd be amazed at how quickly network disks attract files!

Another fiasco we lived through related to printed output from the laser printers attached to both file servers. NetWare has an option that allows you to print "banner" pages (proclaiming the name of the person to whom the printout belongs) and separator sheets. These sheets have a useful purpose, but waste an incredible amount of paper and toner, especially for the majority of print jobs which are just one or two pages. We've compromised by omitting the banners, but leaving the separator pages. People have to sort through printed output and identify their own jobs.

One of our worst problems had to do with the Net3270 gateway. In the first couple of months the gateway hung, or went down occasionally, due to noise on the backbone network linking us to the mainframe computer located at our Computing Centre. This was pretty serious because most of our staff spend their time communicating with the mainframe, and Net3270 downtime resulted in much idle staff time. The major problem was finally rectified by removing the gateway from the backbone and placing it on a dedicated coax cable running to the Computing Centre from our office. Since then we have had other troubles caused by Netbios, but these have been cleared up as our Computing Centre re-wrote Net3270 to bypass Netbios altogether. In the last three weeks we have had no downtime at all.

Results

When the dust had settled, I surveyed all of the LAN users to see how they were using it, and how they felt about it.

Uses - On a weighted average basis, 59% of the time the PCs are being used in 3270 emulation mode using Net 3270. This is not too surprising as about half of the users are programmers or data controllers/schedulers.

30% of the time the PCs are being used with PC level packages, principally Framework III for word processing, but also including FoxBase/FoxPro, RBase, EasyFlow, 1-2-3, Harvard Graphics and a host of others.

E Mail to other people within the department takes up 6% of the time, and E Mail outside a further 2%.

Features - I asked what people liked most about the PS/2s. Bearing in mind that we had all come from either a monochrome 3270 or a monochrome PC1, the most liked feature was perhaps not surprisingly the colour screen, mentioned by 48%, followed by the keyboard (29%), overall speed (26%), and flexibility (19%). Amongst the other beloved features, the overall size, shape, colour and general aesthetics received several mentions.

Top of the least-liked features were the inability to hot-key between sessions as easily as with Irma (23%), the overall speed (16%), and nothing at all (23%).

I asked the same questions for the LAN as opposed to the PCs. Top of the pops were E Mail at 42%, so much easier on the LAN than with the previous mainframe version, and disk handling. Staff find using the disk server vastly better than fighting dozens of floppies. Access to a wide range of shared software was very close, at 39%, then trailing behind came laser printing and using shared files, both with 19%.

Remarkably the highest most-disliked feature for the LAN was "Nothing", with 16%.

Conclusions

The LAN and PS2s have been very well received. Naturally what people like best is what's new - colour, better keyboard, speed and the LAN. From the management perspective I am very pleased with the relative ease with which the LAN went in. We profited by walking, then jogging, then running. I am also pleased with the attitude change on the part of the staff towards PCs, and their acquisition of PC expertise. Finally, the improvement in internal communications through E Mail alone justifies a large part of the expense.

I look forward to building on our experiences so far by expanding the support we provide for end-user computing, and by upgrading some of our PS2s to take advantage of CASE and cooperative development of mainframe applications on the desktop.

I am also gratified that our traditional users such as the Registrar are now knocking on our door to join our LAN, and at least one existing small LAN wants to come on board ours to eliminate their support overhead.

POTENTIAL IMPACTS OF THE NATIONAL RESEARCH AND EDUCATION NETWORK ON RESEARCH LIBRARIES AND THE SCHOLARLY COMMUNITY

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ABSTRACT

Legislation for a National Research and Education Network (NREN) may soon be introduced in Congress. The NREN could create opportunities for major changes in the kind and content of information services delivered by academic libraries to the scholarly community. Examples are on-demand full text delivery, self-generated interlibrary loan, access to electronic library catalogs which include article-level access points, access to non-bibliographic data files and new means of electronic scholarly communications. Libraries and library organizations have important roles to play in the NREN, enhancing access to these and other information resources.

"We expect the revolution in communications to extend the power of our brains. Its ultimate effect will be the transformation and unification of all techniques for the exchange of ideas and information, of culture and learning. It will not only generate new knowledge, but will supply the means for its world-wide dissemination and absorption."

David Sarnoff, 1891-1971
Founder and President, RCA
Wisdom of Sarnoff and the
World of RCA.

Library Automation and Networking

Academic libraries must still purchase, process, store and lend books and journals, but they must also acquire and access information in electronic form. They must do all of these things efficiently in addition to providing access to the universe of information not within their walls. To quote Richard de Gennaro, "Technology is making the resources within the library available beyond its walls, and the resources beyond its walls available within the library". (1) The way libraries manage these accomplishments is in great part related to an increasing use of telecommunication networks. We will illustrate and explain some of the current library uses of telecommunication networks and look at ways an expanded high-speed network which connects private and public sector, business and educational research endeavors will impact libraries.

Processing

Libraries use machine readable bibliographic descriptions to create online public access catalogs in addition to typed, handwritten, or manually produced catalog cards created prior to the mid 70s. Twenty years ago, a library catalog department may have housed 20 or 30 catalogers describing all the new books and journals acquired for the library. We still have all those personally produced records, but today the catalog department has far fewer staff, and those remaining search national bibliographic databases for records which match the new books and journals in hand. They may make minor changes in the records, but they acquire the text of the record over telecommunications lines, depositing them one by one into the local online catalog.

Similarly, libraries use telecommunication links to order new materials through library vendors or publishers. Electronic mail systems are widely used to speed orders to vendors. Sometimes the vendors are able to supply the matching cataloging records along with the books.

When journal issues do not arrive on time, or if missing issues need to be ordered, electronic mail systems are used to claim them. Libraries also dial into large serial vendor databases of journal holding information to determine issue availability.

In these and many other ways, libraries make extensive use of bibliographic or commercial database searching over phone lines, and sometimes, dedicated high speed lines. The size and scope of research library collections and the need to process them efficiently mandate the use of information technologies.

National Bibliographies

The large national bibliographic databases used for processing collections also serve other purposes. The two largest databases are OCLC and RLIN. Current developments in the ways libraries and scholars are using these national bibliographic "utilities" have major impacts on telecommunication networks.

The utilities were developed for library use, not individual use. They continue to be chiefly used for cataloging functions and for resource sharing. However, both organizations have been moving toward providing individual access to their databases. OCLC is about to launch new search software called EPIC, which will allow much more flexible subject searching of the 20 million records contributed by the staffs of the 10,000 member libraries. Direct (not mediated by a librarian) patron use of the OCLC database will then be facilitated. Plans are not yet

made, however, for internet access to OCLC, since OCLC is just now installing a new telecommunication network. However, it is common for libraries using OCLC to offer public access terminals in their library buildings, and with EPIC, individual use of the massive database will be easier and more effective. The Research Library Group (RLG) has already announced its plan to allow individual scholars affiliated with member universities to search its database, RLIN; and RLG has recently completed a pilot project called the Research Access Project which was designed in part to identify needs for direct searcher access not mediated by librarians. Further, RLG has announced internet access to the many research and bibliographic files in RLIN. RLG is installing its own dedicated high speed pathway, linking all the member campuses for materials processing and information transactions. Two RLG libraries, University of Pennsylvania and New York University, are developing gateways to move easily from the online catalog to RLIN.

Interlibrary Lending and Document Delivery

The largest research library cannot afford to own even a small percentage of all published works, so it must be highly selective about building collections to be housed locally. By joining organizations such as OCLC and RLG, libraries have for many years used their bibliographic databases to locate copies of research materials which have not been purchased locally. This is possible because the utilities store information not only describing the item itself, but listing all libraries owning the item. A library using either system can electronically transmit a borrowing request to the holding library, or a queue of holding libraries. Very recently, interlibrary lending meant that once the location of a needed item was found, and the electronic mail request was sent, the person needing the item waited for the U.S. mail to deliver the book or article. With recent advances in telefacsimile technology, high quality, high resolution copies can be made available by scanning and sending via phone lines. OCLC is even planning extraterrestrial library service with the Technical Library at NASA to beam information to astronauts. (2) Very recently, some libraries and library organizations are experimenting with digital scanning and digital sending, using fiber technology and the internet or components of the internet. The RLG anticipates using its dedicated network at night for large volumes of fax transmissions so that rush interlibrary loan requests need not depend on the mail. RLG is also developing a document transmission workstation to speed both the document request and the document itself on their way between libraries and other libraries, and between libraries and scholars. (3)

Although the RLG document transmission workstation is intended to be a critical part of the library document delivery service rather than a multipurpose workstation for scholarly use, the vision of a workstation enabling information to be received directly by the scholar is not a new one. "In 1945, Vannevar Bush urged scientists no longer dedicated to the war effort to turn their creativity to making knowledge more accessible. The device he pictured, which he called a "memex," was a desk which incorporated a numerically controlled microfilm store, reader, and camera. The stored information would include both published works and personal records; several items could be viewed simultaneously at high resolution....The computer had not yet emerged from the closed doors of the wartime cryptography department, but Bush's vision of the scholar's workstation is still a goal for the library of the future." (4)

Electronic Storage of Full Text

Vannevar Bush looked toward microtext for solutions rather than storage of text in digital form, but it is possible that the next step toward Bush's ideal scholar's workstation is about to be taken. Once the library scans or receives the document, and before it relays the document to the requestor's fax machine or computer, the library will store the document in analog or digital form, complete with illustrations, and link it to a bibliographic record for retrieval upon the next request. There is present experimentation with digitization of photographic and other graphic data for storage on compact disk or videodisc. Is this a form of publishing? What are the copyright ramifications? How much storage will libraries use? What involvement will libraries need with optical technology on site? How long should such documents be kept? Will publishers become the archive for their publications, instead of libraries? These and other public policy issues have been cited by Clifford Lynch as areas of great interest to libraries. (5) As scanning technology improves and standards evolve for document compression, the solutions to these questions will be addressed in the near term.

Library organizations such as OCLC and RLG are key to policy development on these and other related issues. At this time, both RLG and the American Library Association, as well as many states which are establishing statewide fax networks, are developing interlending policies and protocols for new delivery methods. Clearly, these policies will affect telecommunication traffic loads, and will lead to the resolution of many copyright, fair use, telecommunication access and scholarly communication issues.

Commercial Document Sources

There is a link with the commercial document delivery sector. Competing with libraries as sources of documents are many nonprofit and for-profit electronic delivery systems. Among these are:

1. ADONIS (Article Delivery Over Network Information Service)
2. ARTEMIS (Automated Retrieval of Text from Europe's Multinational Information Service)
3. Scientific Delivery System
4. EIDOS (Electronic Information Delivery Online System)
5. APOLLO (Article Procurement with On-Line Local Ordering)
6. Transdoc
7. Knowledge Warehouse
8. Project Mercury
9. ISI's Genuine Article Service
10. The ERIC Document Reproduction Service
11. Chemical Abstracts Service
12. University Microfilms International Document Service

It is worth noting that these organizations and the fees they charge affect the library's choices for the most effective way of obtaining needed information. This in turn will affect interlending operations and their cost effectiveness. If commercial document sources were on high speed networks alongside major research libraries or even publishers (a great many academic publications are now owned by a handful of large corporations) some interesting developments might occur. At this time, it is generally less expensive for the end-borrower to use libraries, but only because academic libraries are willing to absorb costs of delivering documents not owned locally to their primary clientele. RLG is considering a pilot project with UMI to include this company's serials holdings in the RLIN database so scholars will have easy access to the choice of using either UMI or interlibrary loan.

Take a moment to think about what part of the scholarly communication marketplace will belong to academic libraries and what part will remain in the private sector, as well as new ways they may be intertwined. The datafile produced by the scholar is the basis for research findings. The database itself will be 'published' by listing and describing it in library resource files in association with ICPSR - like consortia which archive and send copies. The published findings, possibly in electronic form, are indexed by the private sector, as always, burt the indexes are available on library catalogs. Procedings indexes and journal indexes are produced commercially. Libraries are likely to continue to enhance access to listings and delivery of documents, and may move toward distribution systems for not-very-profitable areas such as small scholarly markets, while the private sector will profit through activity in larger academic markets.

Special Collections and Scanned Images

The nature of available documents is changing, too, and in a way which might greatly affect telecommunication traffic. Digitized text, especially text with graphics or other images, consumes a considerable amount of storage space and telecommunication time. There are several pilot projects experimenting with scanning images with the intent of making them available to remote researchers. The Library of Congress' American Memory Project is one example, and the National Agricultural Library's NAIN project is another. In the NAIN project, the National Agricultural Library (NAL) and the North Carolina State University (NCSU) Libraries will establish a telecommunications link through the Internet which will enable NAL to transmit digitized page images of requested material to NCSU. This demonstration project will test the technical feasibility and administrative

structures necessary to capture, transmit, and receive machine-readable page images at remote sites. (6) A benefit to the scholar is clear: special or rare collections unavailable until now for examination without a site visit may be scanned, stored and retrieved from storage for transmission to local campus networks.

Preservation

Those who are concerned with the role of the library as the archive for preservation of information regardless of format are considering questions about the role of the library in preserving electronic images, including questions about the potential of scanning and storage of information as a preservation method. The Commission on Preservation and Access has recently appointed a Technology Assessment Advisory Committee to address these very issues. "Obviously, the goal is not only to produce a copy of a deteriorating item with relatively permanent life and of comparable or even enhanced quality and definition, but to provide copies that can be electronically stored, searched, disseminated, and reproduced in suitable print form from remote locations in a manner that is both convenient and cost-effective for the library and its users. ...Over the next few years, the Committee expects to concentrate on such areas as electronic image capture or scanning, compression and enhancement, optical character recognition, storage devices, transmission networks, workstations, user interfaces, searching algorithms and printing devices." (7)

Union Catalogs

In the past, the library card catalog was usually intended to provide an index to the material owned by that one library. Some groups of libraries had card catalogs called union catalogs because the catalog listed and described material owned by more than one library. It is now common for libraries to join together in international, national, regional and local networks to share the expenses of automating. The online catalogs of these groups of libraries contain information about the collections of all libraries in the shared automation project. This means the concept of a single catalog for a single library is no longer assumed to be the case. At the national level, one of the newest networks for such resource sharing is called LEGEND - Legal Electronic Network and Database. LEGEND provides law libraries with an authoritative database for legal materials and an effective way for some 500 law libraries to create, send and fill interlibrary loan requests using the OCLC Interlibrary Loan Subsystem. (8) It is also very common for regional resource sharing to be promoted through the development and use of regional online catalogs. The MELVYL system in California is a well-known example. The three major research libraries in the Research Triangle of North Carolina is another example, since the three libraries share the use of TRLN, a public access catalog. Some state legislatures have been funding efforts to link research libraries in the state to enhance availability of research resources to the taxpaying public. In Indiana, where the major research libraries all use the same catalog software (NOTIS), a Notis-to-Notis link has been funded for development. In Michigan, all the major research libraries use NOTIS and will be searchable on MERIT. In some cases where the major state resource libraries are not on the same automation system, the linkage is more difficult, but is still being developed. In Colorado, a system called IRVING provides baseline search capability for dissimilar online catalogs. Even the utilities are beginning to look at technical issues of interconnectivity; a RLG/OCLC technical paper is underway.

External Library Resources

Recently, some research libraries have been adding more than local or regional library information to the catalog. For instance, many of the bibliographic records of the Center for Research Libraries collections (located in Chicago) can be added to the catalog of any member. The Center for Research Libraries acquires expensive and often little used research material which then becomes available to all members. The local online catalog containing CRL catalog records will retrieve entries for material located in Chicago and available for loan even if the searcher and the member library is in California.

Journal Article Access in the Catalog

A growing number of libraries are taking this concept further by adding databases to the online catalog for nonbook material such as indexes to journal articles. The index to journal articles may be accessible to the user

using the same search engine as the online catalog if it is loaded as part of the online catalog. Even if it is not part of the catalog, the journal article file is usually listed on a menu along with the book catalog. The library has the choice of adding article level indexing for journals not in its own collections by leasing access to commercial indexes, or it may index only journals in its own collections or the collections of its cooperative automation consortium. In this way, indexes to journal literature are available to any campus network user, or through dial access to the library computer. In the past ten or fifteen years, this could only be accomplished through the use of dial access programs where the trained searcher dials into a remote mainframe mounted journal index made available by database vendors. This is a case where telecommunication based use of data files by libraries is already decreasing. However, the potential for another substantial change in data access exists: the ideal access method for commercial journal indexes might involve internet access made available by the producers of databases rather than phone line access through vendors.

The definition of a library catalog has forever changed. (9) Catalogs no longer provide an index to owned materials, but to materials available globally for access via interlibrary lending or commercial document delivery services.

Direct Search Access to Catalogs

Moreover, individual online catalogs are increasingly available for searching on the internet. The current list on the Humanities Bulletin Board on the Internet contains over 25 major research library catalogs. This could change the process of access to the scholarly record, as research libraries continually increase the size of the databases of machine readable catalog entries through conversion efforts from card form. However, proprietary or commercial files included in individual online catalogs may be problematic for the internet user. CARL, the Colorado Alliance of Research Libraries has, for example, an electronic encyclopedia mounted and available to CARL members. It is not available without password authorization to those dialing in or coming in through the internet.

Information for Distance Learning

As remote access to library catalogs becomes even more universal, libraries become better equipped to support the information access needs of those involved in extension education programs. As the NREN is linked to state or regional telecommunication structures, we envision improvements in access to educational programs available through telecommunication, interactive learning, video and data communication. Even the most remote geographic region can be a local phone call away from continuing education, extension degree programs, teacher training programs, or partnership programs between secondary and higher education. Library, lending, and information service systems supporting such educational initiatives are vital.

Information for Economic Development

Just as information access plays a critical role in extension or distance learning initiatives, so does information access enhance and encourage economic development. Public libraries and state funded academic libraries are sources of business, market, and technical information key to economic growth. Remote access to business and technical information through regional library cooperatives and document delivery systems based on high speed networks are already present in some states and regions, and are under development in others. Expanded access to educational networks for these purposes is in direct support of state-based economies, or third world economies.

MRDF

So far, we have discussed the library's role in using telecommunication networks to access descriptions of printed material. Although the much proclaimed paperless society has not yet occurred, libraries are indeed acquiring information which is made available only in electronic form. Electronic bulletin boards, electronic journals, U.S. government literature indexes published on compact disk, data files and access software distributed on compact disk, and information sources such as the electronic encyclopedia just mentioned are all available in libraries.

Nonbibliographic data is often accessible in the library in machine readable form, and aggregate data sets are widely available through ICPSR (Interuniversity Consortium for Political and Social Research). Some universities involve the library as the source of access to and information about such aggregate data tapes.

The two utilities (OCLC and RLG) have recently announced a cooperative project to make available both cataloging describing the ICPSR tapes and the code books accompanying the tapes. In addition to files from ICPSR, RLG is now exploring arrangements with the Oxford Text Archive, ESRC Data Archive, and the Rutgers/Princeton Center for Machine Readable Texts. Machine readable data files on compact disk as well as in other formats are in libraries of all types, including small public libraries. Library involvement in management of machine readable data files (MRDF) is raising many questions. According to a recent RLG study:

> "MRDF itself is a generic term covering a wide variety of electronic information in terms of both physical format and data content. MRDFs can be a computer program, a collection of raw data, or a combination of both. Data itself may be numeric, textual, graphic, or a mix. MRDFs may exist on floppies, laser discs, magnetic tape, or hard discs. Data files may be static or dynamic. The data itself may be unique or exist in a variety of formats and combinations. The information may be public or private. MRDFs may be stored locally or accessed from a remote site. Some of these files are intended for public consumption, having excellent documentation, while others have been created by individuals for personal use without any initial intent to make the data widely available. Data files of the latter type often have little or no documentation and are not "robust" (thoroughly tested). Some MRDFs may be accessible as they are acquired; others may require extensive programming before they can be used by faculty and students. Individual MRDFs may require certain equipment and/or specific operating systems to be useable. Certain formats and/or publishers of MRDFs may require "stand-alone" workstations, while other sources of electronic information may provide formats and licensing options which allow the data to be networked within the institution. This technology brings a dimension to information resources and their use and management that raises new issues for collection management and development, ranging from identification, selection, funding, and acquisition to cataloging, housing, disseminating, and sharing." (10)

Recently emerging as a major player in access to scholarly data files are the library consortia. RLG has assumed a critical development role through its PRIMA (Program for Research Information Management) project. As a result of PRIMA, several nonbibliographic data files will be available on RLIN. One of these is the MEMDB, the Medieval and Early Modern Data Bank. It was created by scholars at Rutgers University, and through a funded project, was made accessible by search software. The first phase of the project involved publishing the database on disk, but the next phase involves access via RLIN. Another RLIN file is Research In Progress, a file of entries and abstracts of journal articles accepted but not yet published in several journals indexed by the Modern Language Association as well as a number of women's studies journals. RIPD also contains information about funded research. Another 'early alert' file may be a table of contents service from Engineering Information, Inc. for very recent literature not yet indexed. With such a growing variety of nonbibliographic research data available through library organizations as well as in individual libraries, direct use by scholars of these resources is highly likely to increase.

New Forms of Scholarly Communication

A new wrinkle in the development or publishing of research findings and the publishing of research data is now being explored by Johns Hopkins University Medical Library. In this experiment with the publishing process, the text is mounted on a database, accessed by readers, students, and critics who respond directly via E-mail to the author. (11) This interactive process has also been proposed recently by Sharon Rodgers (12) as a way to revolutionize the scholarly publishing process. In her model, a working draft would be circulated to readers electronically before comments are cumulated into the finished version for review by referees.

Libraries and the NREN

Title II of Albert Gore's bill (National High-Performance Computer Technology Act of 1989) creates the National Research and Education Network. Title III addresses the National Information Infrastructure. This infrastructure includes 1) a directory of network users, 2) access to unclassified federal scientific databases, 3) prototyping of computer chips and other devices using centralized facilities connected to the network, 4) databases and knowledge banks for use by artificial intelligence programs, and 5) provision for international collaboration among researchers.

If we examine each element of this "infrastructure" in relationship to academic libraries, we find that academic libraries have a long history of:

1. Using technology to build and maintain directories of network users;
2. Providing access to a variety of databases;
3. Working with applications and systems programmers to develop prototype front-ends, protocol converters, database loaders, search engine software, etc.;
4. Providing access to local and network-based non-bibliographic databases and knowledge banks; and
5. International collaborations related to information technology.

Academic libraries will continue to use information technology to process collections, lend materials, deliver documents, access bibliographic utilities and other database vendors, provide access to local and network-based non-bibliographic databases, and provide access to their own catalogs via the internet. The major difference for academic libraries between the present and the future is the increasing extent to which they must be at the forefront of plans to design the network management system which pulls these resources together and permits our primary clientele to access these resources in a standard, consistent, and intuitive manner.

What then will be the role of libraries as a part of this infrastructure? In a presentation given at the May 1989 meeting of the Association of Research Libraries, Kenneth M. King of EDUCOM cited the Library of Congress (LC) Network Advisory Committee charge to research libraries as related to the emerging national communication network. Libraries will be responsible for "collecting, preserving, organizing, presenting, and managing scholarly information regardless of format, for the design of the network knowledge management system which permits scholars to access information resources in a standard, consistent and intuitive manner, for connecting libraries to the network and managing interlibrary interaction and bibliographic resources on the network, and for supporting scholarly access to network information resources." (13) Taken further, we think the library community will develop directories of data points. Libraries will be responsible for archives of electronic information and for preservation and ensured access to public information. Libraries will be responsible for library-to-library communication protocols. They will be responsible for user education and training in the use of information resources. Libraries have already been critical in the development of standards for command language, and will continue to be critical in implementation of user interfaces with data files, whether they are bibliographic or non bibliographic in nature. The library community has long been active in the standards community (another example is the work of libraries with publishers to encourage the implementation of a standard markup language for electronic manuscript editing) and have gone on record supporting the ISO/OSI standard. Despite the fact that our campus networks and library automation systems are using TCP/IP, libraries have also been leading the way with OSI based pilot projects such as the Linked Systems Project now underway between several large academic libraries, the Library of Congress, OCLC, and RLG. (14)

NREN's Impact on Libraries

In order to accomplish any of the charges proposed by LC's Network Advisory Committee, academic libraries must first have an active role in planning information policy for the campus. Research libraries must ensure that they are connected to the campus networks, so as to provide state of the art telecommunication pathways to external and campus resources. Research library staffing and library organization charts must shift. One recent gaze at the future of academic libraries (15) predicts flatter organizational structures, greater numbers of non-library information professionals, (including computing professionals) and structures supporting the outreach of information services from the library to scholars according to discipline-based needs. These changes

will be mandated by the fact that scholars will increasingly see their local library as one of many sources for the scholarly record. Their needs for assisted information access will occur wherever they work and access information networks -- in their homes, offices, labs and while visiting colleagues at other campuses.

Research Libraries must also form partnerships with other key players in the information infrastructure. A recent example of such a partnership is Informa, a forum for users of IBM technology in libraries. The goals of Informa include emphasis on better communication between IBM and the library community, encouraging innovation, articulation of the role of the library within the educational and scholarly communication process, and stronger partnerships for information access and delivery. In real terms, it is a lobbying effort to help inform and shape vendor-client-application relationships.

At the national level, research libraries must play an active role in influencing the development of national information policies. The NREN legislation is of interest to the Association of Research Libraries' Task Force on Telecommunication, which is working on developing statements defining the implications of migrating to a new national research and education network. As previously mentioned, the Library of Congress Network Advisory Committee has made strong statements on the library community's responsibilities in planning for the NREN. Libraries must therefore be part of the decision-making group which shapes the uses and resources of a new national network. Library voices must be included in the dialogue to answer important questions such as "Who will determine what commercial agencies have information, databases, or services available on the NREN?", and "what will the determining factors be in deciding what information or products will be accessible via the NREN by and for the public good." (16)

What element of the library community will emerge as the agency which represents our voice? One possibility is the Association of Research Libraries. It has in the past functioned as a lobbying group, as does the American Library Association, and as the professional organization closest to the scholarly community of higher education, could well begin to coordinate the policy articulation agenda for academic libraries. Its membership includes libraries affiliated with both OCLC and RLG. OCLC and RLG both have research and development offices staffed with information management professionals and librarians. We recommend that the ARL, perhaps using its Task Force on Telecommunications, should work with OCLC, RLG, and the Federal Coordinating Council for Science, Engineering, and Technology to establish the forum to address and ultimately create the "infrastructure" proposed by he NREN.

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Panel Discussion

National Networking Update: How It Affects Your Institution

Michael M. Roberts
Vice President, Networking
EDUCOM

Susan Calcari
Site Liaison, Information Services
MERIT/NSFNet

J. Gary Augustson
Executive Director
Computers and Information Systems
Pennsylvania State University

Telecommunications are re-shaping the way that universities will teach, research, and collaborate. This panel presentation provided the latest information on national networking initiatives including CREN (the new corporation that will operate the merged BITNET and CSNET), NSFNet, and the coming National Education and Research Network. Panelists also described national legislative and funding issues that are shaping higher education networking for the future, and explained how campuses will be affected by these initiatives.

A brochure describing the NREN is available from the Coalition for the National Research and Education Network, 1112 16th St. NW, Suite 600, Washington, D.C. 20036; phone (202) 872-4215.

(Paper not available)

TOWARDS NEGATIVE ENTROPY: A STRATEGIC PLAN

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ABSTRACT

A fundamental concept of nature is that living systems without adequate "information flow" will utilize large amounts of energy (resources) while tending towards disorder. Our campus is such a living system and it has been the objective of a five-member campus team, with the support of administrative officials, to reverse this process.

After defining the "disorder", we have devised "A Strategic Plan for Communications at Winthrop College." This plan has two major goals: (1) to establish Information Technology standards on a campus-wide basis for information system network service centers and for end-users wishing access to and support from the network service centers, and (2) to install a campus-wide infrastructure network optimizing connectivity and interoperability between and among information processing systems while providing comprehensive end-user access. Our tactics and strategy will be provided together with accomplishments to date. This is a real-time activity with plans calling for budget and specifications by August of 1989.

Towards Negative Entropy: A Strategic Plan

INTRODUCTION

By way of introduction, we would like to provide a conceptual framework from which we can view the information resources and communications within our campus organization. We find it useful to think of our campus as a living system, analogous to single celled organisms, humans, or societies. We then may apply, by analogy, certain ideas from the fields of systems and information theory, and thermodynamics to such a system.

We use the term "system" as a set of units with common properties. The interactive relationships between the units are ones of constraint, control, and dependence. The "campus as a living system" is therefore all internal organizational units, from the academic departments to the office of the president, that function towards common goals in a predetermined structure or hierarchy. This living system is comprised of individuals and groups who process information for the system. In this article, information is considered a measure of the ***order*** or ***form*** of communicated or transmitted media and not the media itself. The "media" is considered to be that matter/energy which is able to be transmitted and assimilated and includes such forms as data, voice, video, graphics, and security signals.

The law of "Degradation of Energy" or "Second Law of Thermodynamics" suggests that disorder, disorganization, lack of patterning or randomness is the natural progress of a system from ordered to disordered states. Information is a negative index of uncertainty or disorder. For an organization to progress in an orderly fashion towards common goals; individuals, groups, and units within the organizational system must be able to acquire meaning or significance from processed information. It is through meaning and acquired knowledge that living systems change their processes to adjust to changes in their environment. Without information, media will be utilized, but no meaning or knowledge acquired. Information provides the power of organization, lack of information results in natural disorder, and the subsequent degradation of the organization.

Winthrop College has as its mission two fundamental aims: (1) the fullest possible development of each student as an educated person, and (2) the preparation of students for professional careers. Education is the effective transmission of knowledge and skills to students. If the college, a living, open system in competition with other similar systems, cannot process information effectively and efficiently within its internal units, it will not be able to reduce the internal strain that such systems experience. The system's organizational and operational integrity will diminish to the point of dysfunction. Biologists associate this progressive systems failure with aging and mortality.

We at Winthrop College are attempting to provide the means by which various media may be effectively ordered and communicated to maximize the transmission of information. We plan to do this by (1) establishing standards for the control and transmission of media as information and (2) creating a campus-wide communications infrastructure for its transmission.

The vehicle for effecting this change is Winthrop's "Network Project Team."

Genesis of the Network Project Team

The committee that ultimately gave rise to the Network Project Team had its beginning in 1980 when Winthrop went in-house with administrative computing. Appointed by the president and named the "Computer Coordinating Committee," it had as its mandate "to ensure that all administrative units desiring computer assistance would be served."

By 1983, campus computing resources, especially microcomputers and microcomputer software, were expanding significantly. In an attempt to manage this rapid expansion of computing resources, the appointed committee was re-commissioned by the administration. The committee was to scrutinize the personal computer purchase requisitions and consult with those departments making requests that did not appear to be cost justified. Having no formal authority, the committee was not regulatory and had no effective role in controlling purchases.

In 1986, the President appointed a "Computer Utilization Committee," which was comprised primarily of the members of the previous committee. Moressi, Laster and Mitlin were asked to serve again, along with three other persons. No explicit directives were provided except by way of the name of the committee.

At our first meeting, in December 1986, there was a consensus from the group that we needed some definitive objectives the committee could attain. While exploring possibilities, we got into a rather animated discussion about the great difficulty the campus information resource centers experience in trying to provide services beyond their immediate physical domain. We also recognized that we were not even able to share resources because of the absence of standards between systems.

The committee decided it would define the problems and do a preliminary analysis of data communications, or lack thereof, on campus. The study would define the ***scope*** of the project, identify the ***information service centers***, and address the issues of ***standardization of services*** and ***campus communications***. With this information in hand, we would recommend to the President a course of action for the committee: plans for the establishment of a campus-wide network for Winthrop College.

The President and other senior officials became convinced of Winthrop's communications problem. We were directed to begin a feasibility study and to search for practicable options for networking the campus. At this juncture, there was no stopping us! Our next move was to identify ourselves as a group with a specific purpose. We adopted the name "Network Project Team."

Evaluation of Campus Disorder

In preparing the feasibility study, we found that information technology disorder fell into two categories: technical and non-technical. We further observed that the non-technical disorder, which can be defined as lack of coordinated control, resulted in the technical disorder.

- The three computer centers on campus use different computers and dissimilar communications protocols and transmission media. Sometimes there are three types of cable covering the same route.

- Communication line facilities evolved as opposed to being the product of design; there are no provisions for growth or change. There is no allowance for the integration of such communications media as voice, data, security systems, graphics and video.

- There is no single source to identify what communications lines and conduits exist and where they are located.

- Telephone lines have to be used for local connections because of the absence of conduit or other forms of direct connection.

- The telephone system and its administration operates independently of the computer centers. This arrangement precludes careful planning for multi-media transmission.

- Special lines outside of the telephone switch must be requested when attempting to communicate on or off campus with computers or terminals.

- An inordinate number of personal computer hardware/software systems have been purchased for use by Winthrop personnel. Service center resources cannot begin to support the great variety of hardware and software systems.

- No guidelines or standards exist for the acquisition of personal computer hardware and software. Thus, users are often left unsupported and unable to properly utilize their systems.

- Without controlled coordination of the information technology function, each of the existing service centers make independent attempts to communicate and share resources. The processes employed are usually complex and circuitous.

- The absence of standards impacts functionality, service and budgets.

DEFINING THE CAMPUS ENVIRONMENT

Another component of the feasibility study was a definition of the campus environment.

Two important factors that must influence the formulation of systems objectives are *organizational constraints* and the *people who use the system*. A term currently being used does a good job in describing these factors. It is called "organizational culture." Organizational culture addresses issues of money, people, time, and facilities and how each are allocated. In other words, the organization defines its priorities by the very nature of its existence. It follows that an understanding of this "nature of existence" is paramount to planning for change.

Because of this maxim, a determination of the culture of our campus was in order. Our starting point was the identification of campus-resident providers of computer services, and consideration of the niche or placement each occupied in the organization.

We defined three information system service centers: Academic Computing, Management Information Services and Library Information Systems. Each utilized a combination of mini-computers and micro-computers representing multiple vendors and had no protocol or media compatibility with each other. Each center was located in a different building.

The Academic Computing Center's primary role is to provide the tools needed by students and faculty for course-work requiring computers. We found that another important role has emerged and is growing in the area of faculty and student research. The Academic Computing Center also provides management of curricula and other functions directly associated with academics. Communications with other colleges and universities are made possible by communications links through the Academic Computing Center.

The role of Management Information Services is to provide computing resources for administrative functions common to all colleges and universities. The scope of services has been extended to include the administrative functions of the academic units.

The Library Information Systems center exists to provide a computerized public access catalog and internal library record keeping. Provision is made for access by author, title, subject and keyword.

As for the organizational placement, each of the service centers resides in the fourth layer. The Academic Computing Center and Library Information Services are aligned under the Academic Vice-President. Management Information Services is controlled by the Vice-President of Finance and Business.

Given this organizational structure the three centers have had no common ground for achieving unity of purpose.

The remaining component in defining the campus environment was to determine what other isolated computer uses existed, if any, and what functions were being performed by the computers.

To accomplish this a one page Information Technology Census form was prepared in summer of 1987 that asked each department to list the number of terminals and "intelligent" devices located and utilized in their area. We asked for manufacturer, model, and description.

Analysis of the data revealed that the campus used 6 types of display terminals and over twice as many types of printers. We had at that time 365 personal computers representing 13 different vendors in 24 buildings.

Since the display terminals were connected to the service centers, we knew what functions they were performing. We also knew that 170 of the personal computers were in PC laboratories. Exactly what was being done with the remaining 265 personal computers was unknown to us.

STRATEGIC PLANS

Our strategic plans are for the development of an Information Resource infrastructure at Winthrop College. The plans have two primary goals: (1) the establishment of campus-wide standards for information resources, and (2) the installation of a campus-wide communications network infrastructure.

GOAL 1: to establish Information Technology standards on a campus-wide basis for information system network service centers and for end-users wishing access to and support from the network service centers.

Objectives: Plan of action to:

O(1): *Provide network software standards.*
Timeline: July, 1990

O(2): *Provide network architecture and hardware standards.*
Timeline: July, 1990

O(3): *Provide specifications for a data exchange standard between computing systems.*
Timeline: July, 1990

O(4): *Develop standards that will define resource services the information service centers provide.*
Timeline: July, 1990

GOAL 2: **to install a campus-wide network infrastructure optimizing connectivity and interoperability between and among information processing systems while providing comprehensive end-user access.**

Objectives: **Plan of action to:**

O(1): *Define the campus's information resource service facilities.*
Timeline: December, 1988

O(2): *Define the campus's communications environment.*
Timeline: January, 1989

O(3): *Evaluate several networking technologies that could meet the needs of Winthrop College.*
Timeline: August, 1989

O(4): *Compare networking alternatives on a cost-benefit basis.*
Timeline: August, 1989

O(5): *Recommend establishment of organizational structure(s) for the support of the communications network.*
Timeline: July, 1990

O(6): *Develop proposed system specifications.*
Timeline: August, 1989

O(7): *Implement system in phased approach.*
Timeline: 5 year installation.

PLANS vs REALITY: Accomplishments & Adjustments

GOAL 1: Establishing IT standards

Standards are to be:

- developed with consideration of the finite resources of the service centers.
- developed with consideration of the average user.
- maintained and updated on a regular basis to reflect current and anticipated changes in technology and needs of users.
- flexible enough to allow for information systems development and expansion, and for changes in user's requirements.

O(1): Establish network software standards.

We are considering standards that are not only compatible with currently used technology, such as the International Standards Organization (ISO) Open Systems Interconnection (OSI) and Transmission Control Protocol/Internet Protocol (TCP/IP), but those that would ensure flexibility with future technological advances.

O(2): Provide network architecture and hardware standards.

Hardware interfaces must be selected based on the current equipment and near term hardware expansions of the service centers. We have yet to decide on an appropriate architecture and hardware interfaces.

O(3): Provide specifications for a data exchange standard between computing systems.

The three service center directors are coordinating the effort to establish standards for communications between our host computer systems. In addition, the committee is considering such systems as minicomputers, microcomputers, telephone circuits, video systems, security and emergency systems to determine their capability to adopt a data exchange standard.

O(4): Develop standards that will define resource services the information centers provide.

Standards will be developed for the three campus information systems and users of such services. These should clearly define the hardware, software and systems consulting and support source(s) and resources to be provided by the centers.

GOAL 2: Install campus-wide communications network infrastructure

O(1): Survey campus for Information Resource service facilities.

This has been accomplished. The three major information service centers on campus have been identified: The Academic Computing Center, Management Information Services, and Library Information Systems. Considerable detail has been accumulated on end user systems and data entered into database systems for analysis.

O(2): Survey campus for all existing communications lines and services, including telephone.

Most buildings on campus have been surveyed and data has been recorded as to the number of voice lines both in place and required and the number of data lines in place and required. Data has been entered in a database system for analysis.

O(3): ***Evaluate several operationally feasible networking technologies that may best meet the needs of Winthrop College.***

Several vendors have been invited to informally review Winthrop's networking needs and provide some viable solutions. Members of the NPT have also visited several sites where networks of interest were installed.

A hybrid data switch/LAN is visualized. We have already had several companies demonstrate data switching capabilities on our campus.

O(4): ***Compare networking alternatives on cost-benefit basis.***

We have not settled on any unique alternatives to provide definitive costs, although we have made some estimates based on a hybrid data switch/LAN.

The college's administration informed us of a possible "Step 12 Formula" funding for the network through the South Carolina Commission on Higher Education. We applied for this funding, estimating costs for using a data switch with existing telephone wires as opposed to rewiring the campus for a LAN configuration. On a projected basis, it appeared to be more cost-effective to eventually rewire the campus thus giving us the option of using a full LAN or a combination switch and LAN.

O(5): ***Organizational structure for support of network.***

Two preliminary steps were taken in this direction:

1) in our proposal for network funding to the S.C. Commission on Higher Education (6/89), a budget allocation was made for campus network staff.

2) we reviewed campus Information Technology coordinating problems with the vice President of Academic Affairs and President (9/89).

O(6): ***Develop proposed systems specifications.***

We have inventoried most all types of computing and communicating equipment on campus, identified most all buildings needing communications down to the room level in need of communications, located communications conduit in existence. For each of the service centers we have analyzed the current data traffic flow and expected traffic flow. With this data we have listed a number of specifications for service center and end user requirements.

O(7): Implement system in phased approach.

The *first phase* of the LAN implementation will be twofold: (1) to provide for all *existing* end-users, service to the host-systems through the network, and (2) to install a fiber optic backbone between existing host-processors with standard protocol software. The *second phase* will be to expand LAN facilities and install network software to provide for complete campus connectivity and interoperability.

SUMMARY

Conceptually, we relate our campus organization to a living system; a system that utilizes energy to do useful work. The better organized a system is, the greater is its so-called "information content" and its ability to use energy to do constructive work.

Our actions over the past two years have been to develop a plan and specifications for a more ordered structure for media such as data and voice; and for an appropriate means of transmitting these media both within and external to the organization.

We have set the plan into action and accomplished such tasks as defining major information resource centers, surveying the campus for central processors and their associated major software systems, and for communications equipment. We surveyed for voice and data lines on a room-by-room basis in most campus buildings. We surveyed for existing underground conduit and subsequently developed AutoCAD diagrams of the campus graphically depicting our results. We have invited interested vendors to present their networking strategies and made site visits to academic institutions and corporations. All this was done in an attempt to help us better define our information resource "problem" or disorder.

The data have been analyzed, problems identified, and the structure for solution(s) provided. We have submitted analytical reports and provided communications demonstrations to the upper administration. We developed a strategic plan for campus information resource standards and a communications infrastructure, and submitted a proposal for funding of the project to the State of South Carolina.

We plan, with the continued support of our administration, to be able to effect changes in our organizational environment that will allow us to progress to a state of "negative entropy." With these changes we may continue to grow in functionality, productivity and complexity with the ever increasing information demands made on our organizational units.

CHANGING WORLD BRINGS STRATEGIC CHANGES AT PENN STATE

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In 1983-84, The Pennsylvania State University developed its first Strategic Plan for Telecommunications that projected needs for 10 years. Now, five years later, changes in the world of telecommunications and computing have forced a new look at where the University should be heading. Completed in October of 1989, the new Strategic Plan recommends changes in some cases but reaffirms many of the initiatives contained in the earlier report. For example, the 1984 Task Force thought it was daring to call for 64 kilobits per second to every desktop. Yet today, Penn State provides networks performing at 10 and 80 megabits per second and expects even higher speeds in the future. On the other hand, the fiber optic network and the intra-building cabling standard have been re-validated. Besides providing a clearer focus on the future, an important objective of the strategic planning process is to foster increased confidence and renewed commitment to view telecommunications as a strategic resource at Penn State.

Introduction

Penn State's geographic dispersion creates unique communication problems. Until five years ago, many units of the University solved these in a mostly ad hoc and uncoordinated manner. However, in October of 1983, as the breakup of AT&T was imminent and telecommunications technology was advancing rapidly, the President's Office created a Telecommunications Task Force to study the problems and opportunities these changes presented in the context of Penn State's system-wide needs. The Task Force, representing the University's broad interest in voice, data, and video, presented its Strategic Plan for Telecommunications in October, 1984, after an intensive year of work. The Plan recommended how the University could best approach its changing telecommunications environment.

The focus on telecommunications allowed substantial progress in upgrading Penn State's telecommunications infrastructure, guided mainly by the objectives and strategies contained in the initial plan. With rare exception, the objectives are being implemented as planned.[1] After five years, it was time to assess changes in services, technology, and the institution and to do a mid-course correction. A planning group similar in composition to that of the original Task Force was established. Its members represented the major users of telecommunications and other support organizations upon which telecommunications has an impact. This Telecommunications Task Force II deliberated an average of two full days per month from January through September of 1989.

Mission Statement

Based on the charge to the Task Force by the Executive Vice President and Provost and on its own assessments, the Task Force took as its mission:

> To develop an overall telecommunications strategy for the University in support of all aspects of the University's mission;
>
> To define a telecommunications system to accommodate the voice, data, and video communications needs of the instructional, research, and public service programs engaged in by all academic units of the University, and to similarly accommodate the administrative and academic support needs of the University.

External and Internal Assessments

The Task Force recognized the emphasis being placed on economic development by Pennsylvania's Governor and by the Penn State administration. The members learned that the pool of high school graduates is declining, that research activities are increasing, and that education will have to expand beyond the classroom.

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[1] Arms, Caroline. Campus Networking Strategies. Digital Press, 1988.

They also found that federal regulations are changing, communications standards are being developed, and technology is advancing, opening new telecommunications opportunities-but also setting new challenges. Internally, it could be seen that competition for prospective students will intensify, Penn State will be embracing partners beyond traditional campus boundaries, and the University will be required to do more with less.

The Strategic Plan

To meet the needs it identified, the Telecommunications Task Force II has formulated a series of Goals and Strategic initiatives that will form the basis for future yearly Action Plans and which are the focus of this paper.

GOAL 1: Increase the ability of users within the Penn State telecommunications network to freely exchange information in support of teaching, research, and public service.

The focus of this goal is primarily on computers, because the Task Force believes that the next plateau in the development of the University's computing resource lies in greater interoperability between devices, ranging from desktop computers to large host centers. Effective research and education are dependent upon good communication, particularly in an environment as geographically dispersed as Penn State's. To achieve such communication, there must be a physical network that allows devices to be connected together, and a standard data communications protocol that will allow the computers to "talk" to each other.

1.1 Devise or adopt telecommunications standards as appropriate.

The first strategic initiative under Goal One recommends that the University continue devising and/or adopting telecommunications standards as appropriate for Penn State. The Office of Telecommunications (OTC) has already developed standards for backbone networking protocols, for cabling between buildings, and for wiring within buildings.

Standards will be particularly important as classrooms are modernized. The Task Force believes that classrooms equipped with contemporary technology to enhance teaching will become an important University resource of the future. Developing models for general-purpose classrooms that incorporate these resources should become a high-priority effort. Such classrooms should enable teachers to use computing devices and video units within the classroom and to connect to resources external to the classroom through data and video networks. Standards will enable this flexibility.

1.2 Enforce telecommunications standards

Clearly, however, standards do no good if they are not followed. The Task Force strongly believes that the flow of information in a major comprehensive university is as important as the flow of electricity and running water. Standardization of cabling and wiring is essential to the uninterrupted flow of information, and it is very important that local decision-makers not undermine the effectiveness of Penn State's communication system by electing

not to follow the standards. Such actions have significant impact on the future productivity of users and ultimately will cost the University more money when enhancements to the wiring system have to be made on a piecemeal basis. Decision-makers must be encouraged to follow standards.

1.3 Define and implement standards for electronic security

As reliance on electronic information grows, so does the need for security standards. Developments in software and advances in hardware are creating new approaches to electronic data security that may be of value to Penn State, which now relies on a physically separate network for sensitive administrative data. If all users could be on a single public network, costs could be reduced and the network would be easier to use, more flexible, and more functional. A planning group should be formed to define a Penn State standard for data privacy and electronic data security that takes into account the various levels of security required for administrative and research data.

1.4 Convert the Penn State network to the new OSI standards

The Penn State community's need for communication extends far beyond the boundaries of the University, and standards are as important to the flow of information externally as they are internally. OSI [Open Systems Interconnect] is a new international set of standards that will go a long way toward supporting the level of interoperability needed within the Penn State network. A planning group should be convened to develop a Penn State profile that will identify the specific OSI protocols to be used at the University and a small advisory group should be created to coordinate the implementation of these standards.

1.5 Increase connectivity by providing more LAN support

Local Area Networks (LANs) are physical networks that provide a department with opportunities for easy exchange of information among its members. Many departments lack the technical expertise necessary to design, install, and manage such a network. The Task Force recommends that telecommunications services be offered to support these departmental LANs.

1.6 Extend modern networking capabilities into each building on each campus through installation of standard wiring

As cable upgrade projects are completed to provide high-speed communication between buildings at each campus, the advantages of this cabling system must be extended into the buildings, most of which have not been wired for modern data or video communications. Intra-building wiring is critical in order to enable departments to easily install LANs and to have them connected to the high-speed data backbone.

GOAL 2: Provide equal service for similar applications at all Penn State locations

Goal two recognizes that Penn State's telecommunication needs range from simple telephone calls (perhaps to or from a County Extension Office), to

high-speed access to supercomputers at other institutions, to delivery of instruction to on- and off-campus sites. The location of Penn State faculty, staff, and students should not disadvantage them in doing their jobs.

2.1 Provide systemwide high-speed access to the Penn State data backbone

Penn State's data backbone is especially critical for the faculty and students at the other campus locations, where information resources are not as varied or rich. By establishing high speed data links through regional communication hubs, the high-speed data backbone is being extended from University Park to all campuses, allowing faculty, staff and students access to national and international networks in addition to all university data services.

2.2 Provide all locations with dial-in access to Penn State data services

Another important means of accessing Penn State's computational resources is through dial-in connections. At University Park, faculty and students in their homes can access University computing services for the cost of a local phone call through a dial-in connection. Similar local access should be provided at other Penn State locations.

2.3 Work with Penn State information providers to attain equal access to voice-accessed information services

The voice information services that Penn State offers must also be equally available to all. Examples of such services include TIPS (Telephone Information Penn State) and the Registrar's voice response system that allows automated registration and drop/add transactions. Like computer-based information services, these information resources should be available on the same basis at all campus locations. The responsibility for providing these information services rests with the administrative offices in charge of the service--and thus the funding justifications should come from the information provider. The Task Force does, however, recommend that OTC continue to assist the information providers in developing these services.

2.4 Continue to install digital telephone switches (PBXs) and to upgrade telecommunications cable plants at all campus locations

The digital telephone switches that have been installed at several campuses make possible the larger menu of useful features (such as touch-tone dialing, 3-way conferencing, and call forwarding) that have been enjoyed for some time at University Park. As new switches are installed at the campuses, the telecommunications cable plant must also be upgraded.

2.5 Expand the Penn State satellite network

In order to derive still more benefit from the use of satellite technology for educational purposes, four enhancements to the Penn State satellite network are proposed. First, a second satellite downlink is required at all campuses (five have them now) to allow simultaneous reception of two events at each campus, thus expanding the opportunities for service (and for revenue).

Second, downlinks at County Extension Offices would take advantage of these convenient locations for groups to view instructional material. Because satellite receivers at the county offices would provide benefits for the Extension Service, for the University, and for each county, it is appropriate to divide the cost among those entities. A third enhancement proposes modifications to the satellite transmitting equipment to allow simultaneous transmission of two programs. This would alleviate scheduling conflicts, especially for programs run during early evening hours, or that coincide with short-term seminars. Finally, the Hershey Medical Center needs the capability to broadcast via the University Park transmitter for continuing Medical Education. This recommendation, which alters the original plan to install a transmitter at Hershey, eliminates the need to have specialized operational and maintenance personnel at Hershey.

2.6 Expand videoconferencing capabilities

The University has two videoconferencing systems in the early stages of development. The first has operated for four years and originates from specialized teaching studios at three campuses. A fourth will be added in spring of 1990. This system is particularly useful for credit course instruction. The second system, first demonstrated in 1988, is oriented toward administrative uses or small groups. It uses desktop workstations with built-in cameras and microphones. The Task Force recommends that both systems be expanded to include additional sites.

2.7 Help expand PENNARAMA cable service throughout the Commonwealth so as to serve all Penn State campus locations

Television is also a means of bridging the distance barriers between the University and the citizens of Pennsylvania. PENNARAMA is a 24-hour-a-day instructional service delivered to some 800,000 cable subscribers. It is provided through local cable companies via a network supplied by a non-profit consortium of cable operators known as PECS. There is no charge to the University for using this network, but so far it reaches only eight Penn State campuses. OTC should work to persuade the eligible cable operators serving other Penn State campus locations to carry PENNARAMA and to work with PECS to provide services to all campuses.

GOAL 3: Expand telecommunications support for all of Penn State's instructional research, and public service activities—wherever they are delivered

Because Penn State's clientele is becoming more widespread, telecommunications support must expand beyond the campuses and the county offices. Penn State faculty and students, for example, are increasingly involved in national and international projects and activities.

3.1 Extend network access to non-Penn State locations

There is a need for access to Penn State's information resources in non-traditional places like a farmer's field or a prospective student's home. Technologies like cellular telephones can potentially meet these needs--and

OTC should closely track the development of such technologies to ensure maximum benefits from them.

3.2 Provide access to data services not available through national research networks

Faculty and staff are beginning to need access to commercial or public service databases. These databases are not generally available through the networks used by researchers and to which we are already well-connected. Penn State today has no way of providing this new access. OTC should develop and implement a solution for providing this access to the Penn State community as soon as possible.

3.3 Provide greater support to Penn State's increasingly important international programs

The support required for international programs is worldwide in scope and encompasses a wide range of services. First, OTC should appoint a liaison to the Office of International Programs to advise and assist the Office as well as faculty and staff in international communications. Second, the Office of Computer and Information Systems should encourage extension of higher education networks to Penn State's international partner institutions in order to provide such services as electronic mail--and to enable these partner institutions to access Penn State's information resources, regardless of their distance from Pennsylvania. Third, Penn State should seek federal grants from agencies such as the United States Information Agency to support educational programs and to improve communications to partnership institutions. Finally, Penn State should arrange a seminar with other institutions that have similar international programs to discuss how education can best be delivered to institutions in other countries.

3.4 Wire residence halls for computer and video services

Penn State's data network needs to be extended into the residence halls. It is the Task Force's view that students will require--and demand--network support for their own computing devices, especially as the number of courses requiring use of computers increases and as more information resources become readily available. The Task Force believes this need will become intense within the next five years and plans should be made to wire the residence halls for data services within that timeframe.

3.5 Examine solutions that would allow calls to be answered transparently from a multi-campus pool or at home.

During peak periods, many offices, particularly at University Park, experience overload of their telephone lines because of the large number of calls being attempted to a relatively small number of support personnel. With new telephone technology, it is possible to route calls transparently to support locations throughout the state and take better advantage of trained personnel at the campuses and talented individuals who may be home-bound such as the elderly or the handicapped.

GOAL 4: Through education, training, and other activities, assist faculty and staff in making full use of Penn State's telecommunications resources, thus helping to increase their productivity.

Goal Four is concerned with the educational activities that are needed if all of our faculty, staff and students are to make full use of telecommunication resources. This is very much like the technology transfer mission of the Cooperative Extension Service, whose techniques have been refined over the past 75 years. The following three recommendations define techniques to promote user adoption.

4.1 Create a group of "utilization specialists" for education and support.

The first step toward successful technology adoption is to create a group of "utilization specialists" to provide education and support for University users. These specialists would work with individuals and groups to make them aware of telecommunications resources, services and features that are available, offer activities to stimulate interest, help users with product evaluations, create opportunities for user trials and support the integration of technology into existing work processes.

4.2 Establish a volunteer facilitator program

A second technique for promoting adoption of services is to establish a group of volunteer facilitators from among the early users. These volunteers serve as local consultants and become advocates for change. Because their early adopter status makes them well respected by their peers, this group has great impact. This program would recognize the leadership role of these people, provide them with the latest software and information, and supply them with support materials to use with their peers.

4.3 Increase dissemination of information about telecommunications services

A third requirement is to better disseminate information on technology improvements and enhancements. Aggressively done, this can call attention to new applications and increase the level of interest. A variety of options can be implemented to accomplish this objective including printed newsletters and electronic bulletin boards.

GOAL 5: Identify new technologies that will enhance telecommunications at Penn State

Goal Number Five is closely related to resource implications, and calls upon OTC and others to identify new technologies that will enhance telecommunications at Penn State.

5.1 Continue an aggressive program of testing and prototyping new technology

A continuing, aggressive program of testing and prototyping is essential to remaining competitive in the field of telecommunications, where changes are occurring almost daily. Lack of funding in recent years has hampered

development in some areas. Future developments are dependent on prototyping to avoid wasted money in full-scale implementation of projects and to move forward as new technology makes improvements possible.

5.2 Position the university to be able to take advantage of new technologies when they become available

Clearly, the University also needs to be able to take advantage of emerging technologies that show promise for the Penn State system, such as ISDN and HDTV. It is OTC's responsibility to stay abreast of developments, to evaluate those technologies through its prototyping activities, and then to appropriately integrate them into the Penn State network.

ACTION PLAN

After reviewing its goals and strategic initiatives-and the resource implications-the Telecommunications Task Force set about establishing priorities to be accomplished in the first three years of the Strategic Plan. The first year's budget request, for 1990-91, includes the following projects:

* First, the University is obligated by contract to continue T-1 service provided by an independent carrier to the Hershey Medical Center. This service will be extended to the Capital Campus in 1990.
* In addition, because only partial funding is available to upgrade Capital's local telephone switch and cable system this year, the remaining balance of funds are needed in 1990-91 to complete the project. To limit central funding requests for this type of work in any one year, two other campus upgrades have been pushed out to 1991-92 and a much-needed cable upgrade at Behrend has been stretched over a two year period.

In addition to these contractual obligations, there are several projects that need to be continued from previous years:

* The University Park cable upgrade, which will provide the necessary fiber optic, coaxial, and twisted pair cabling to all major buildings at University Park. Continuation of this multi-year project is a key factor in scheduling other major activities, including development of the high-speed data backbone, installation of intra-building cable, and expansion of video services.
* The regional hub project, which not only supports increased data transmission speeds, but also provides higher reliability through improved network control and monitoring capabilities, and enables the extension of the high-speed data network to the campuses.
* The University Park Data Backbone - Phase II, which will allow current data switch users to take advantage of the benefits offered by the University Park high-speed network at no additional cost.
* Extension of the data backbone to other campuses, which will allow higher speeds, better access, and more local control over campus networks. Such control will facilitate development and expansion of local networks by campuses.

* The campus PBX replacement and cable upgrade project, which in 1990-91 will provide for the first year of a two-year project to upgrade conduit and cable and to expand the local telephone switch at Behrend.

Of the new projects recommended by the Task Force, eight were selected for funding in 1990-91, but six of those are not entirely new.

* Two deal with increased staff and departmental allotment adjustment.
* A third is to make permanent a full (broadcast quality) video link that would give Hershey Medical Center access to the satellite uplink at University Park and circumvent the need to install a costly satellite uplink at Hershey. This is currently provided on an ad-hoc, trial basis.
* Fourth, satellite downlinks at the campuses and appropriate extension offices would add important flexibility and functionality to the network.
* Fifth, a request for prototype funds would make permanent an arrangement that has been temporary in the past, providing a continuing source of funds to assess the application of new technology into our environment, and limit the risk incurred when undertaking new projects.
* Sixth, we are also recommending an expansion of our current videoconferencing facilities, building on existing capabilities.

There are two completely new projects for which funds are requested.

* Dial-up data connections at the campuses to enable faculty, staff, and students to locally access Penn State's information resources from their homes; and
* Intra-building wiring at University Park to install standard wiring within buildings at University Park. It is now time to begin an overall infrastructure project to bring buildings at University Park to the same level as those at other campuses.

CONCLUSION

Five years ago a strategic plan was presented that, in hindsight, provided a strikingly accurate vision of the University's future--and the key role telecommunications would play in helping to realize that future. Today, there is no doubt that the plan has been instrumental in setting a strategic direction and that the University community is reaping the benefits of our work. However, there are even greater benefits to be gained by maintaining momentum. The continued investment in the use of telecommunication technology to support the mission of a University such as Penn State is critical, and underscores the need for a comprehensive, up-to-date plan.

Phase I of A Comprehensive Approach to the Planning and Design of a Multipurpose Fiber-Optic Cabling Plant

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Frostburg State University's rapid growth in data communication has saturated the current facilities and generated a need for a new infrastructure. During the same period, other communication and service needs have emerged or required enhancement. The planning process, which was driven by data communication, has been expanded to support and service data, voice, video, environmental control, campus identification card system, security video, FDDI, appropriate redundancy, and other future applications. The concept of a universal cabling plant was developed.

This paper will deal with Phase I - Planning and Design strategies used to synthesize the various technologies, capital and human resources into a comprehensive design.

Introduction

Frostburg State University (FSU) is one of the eleven constituent institutions of the newly created University of Maryland System. FSU's main campus is located in the town of Frostburg in Western Maryland. The University also offers courses in Frederick, Maryland and at a new Hagerstown Center in Hagerstown, Maryland. In the fall of 1989, FSU's enrollment was 4127 undergraduate and 659 graduate students for a total of 4786.

The Office of Computing Services supports all aspects of administrative and academic computing at the University. Over the last few years, FSU's growth has created a stronger need for computing services. In just the last year, FSU has increased the number of users and computing power by over fifty percent.

The growth and evolution of information systems at Frostburg State University within the next five years will be the most profound in the history of the University. The major reason will be the establishment of a network which will increase computer access by approximately 400 percent. In attempting to develop a strategy to deal with this evolution, the Office of Computing Services has recognized the need to incorporate new technologies and provide the flexibility to adapt to unforeseen developments. With FSU's next major technological innovation occurring in the communications, the connectivity of humans and machines is an extremely important issue.

Planning Strategies

With the current communication facilities saturated, the plan is to accouter a cabling plant design which could be easily managed, flexible enough to accommodate changes in technology, cost effective, quickly installed, immune from electromagnetic interference and service a variety of applications. Other administrative units were experiencing the same growing pains as the Office of Computing Services. The planning process, which was driven by data needs, was expanded to include these needs as well. These other functions and/or uses are considered to be of equal importance in the cabling plant design. Fiber-optics has been proposed as the media of choice.

Fiber-Optic Uses

In the fall of 1988, FSU contracted Digital Equipment Corporation (DEC) to conduct a feasibility design and estimate cost of the cable plant. DEC was provided with the

goal to design a cable plant to support the following uses: data, voice, interactive video, future Fiber Digital Data Interface (FDDI), security video, environmental control, campus identification card system, and any other future applications. As a protection against downtime, redundant fibers have been added to take over upon failure of the primary systems.

Advantages of Fiber-Optics

Fiber-optics was chosen for the following reasons:

1. **High speed and enormous bandwidth for data transmission** - No argument here. The only problems is the ability of the hardware to deal with the speed of the fiber.

2. **Immunity from interference and crosstalk** - Living in the mountains of Western Maryland, immunity from electromagnetic interference was an extremely important feature. During the summer months, the current twisted-pair wiring is hit by lightning at least 8-10 times per season at a cost of repair between $30,000-60,000 per fiscal year.

3. **Security** - Any attempt to tap into fiber-optic will result in immediate detection. This may be an overstated feature for higher education.

4. **Can be used for a wide variety of applications** - There is a wide variety of fiber-optics in use today. Fiber is becoming increasingly used for data, voice, connections between microwave facilities, local-area networks, and etc.

5. **Low transmission loss** - The development of optical fibers over the last few years has resulted in a cable with very little transmission loss. Low transmission loss extricates the implementation of communication links.

6. **Potential long range low cost** - The cost of cabling and the labor to install additional applications is reduced and/or eliminated. The fiber-optic infrastructure provides the platform for these applications. Also, due to the fact that fiber is very small, the current communication-duct system will not need any changes. The current four (4) inch conduit will be more than enough room for all aspects of the cabling plant.

7. Reliability and life - Loose tube optical fiber is extremely durable and should last 20-30 years.

Basic Design and Topology

In designing a cabling plant to serve multipurposes with different technologies, you can not depend upon one topology to serve all your needs. In networking, the primary logical topologies utilized are bus, tree, ring, star, and point-to-point. If you are to serve multiple technologies in your design, multiple logical topologies must be available for all users. Therefore, any design must provide for all other logical topologies to exist in harmony and without placing unnecessary restrictions on each other.

FSU's design is based on a multiple star topology. The star topology serves the cabling system by providing maximum flexibility and at the same time minimizing costs. The system can accommodate other technologies with minimum disruption to other systems sharing the cabling plant. This is accomplished by equipping the cabling with a universal connection regardless of application.

Presently, FSU plans only to provide fiber-optics cabling between buildings. For data communications inside the building, thin-wire ethernet will provide the communication link to users. In other applications, the appropriate copper-wire technology will be implemented. There seems to be no need to bring fiber to the outlet at this point in time. By positioning the fiber distribution equipment in good size rooms with easy access to the conduit, fiber to the outlet can be added on a building by building basis in the future.

The main campus was divided into three major areas, thereby creating three major implementation phases totaling twenty-nine buildings. In Phase I, the main distribution frame and two other intermediate distribution frames (these are usually referred to as hubs) as well as other strategically located buildings were chosen because of their primary importance. The main distribution frame provides a single point of control for the star and allows for easy system administration. The two intermediate distribution frames create a second level of administration and control for the additional stars. In total, three (3) hubs and seven (7) buildings are included in this phase.

The hubs are extremely important in any design and should be selected with a great degree of care. The main hub needs to be centrally located on the campus, have excellent access to the communication duct system, and provide a

reasonable amount of floor space to house the equipment room. This room will require enough space to store wall mountable interconnect centers for cable, fiber distribution equipment rack to handle all the fiber splices, and server rack for couplers, transceivers, terminal servers and etc. It is important to note that the main hub does not have to be your computer center building. If properly designed, any building can serve as the main distribution frame.

Phase II consists of the academic and administration buildings not considered to be primary in Phase I. These buildings serve as classrooms, faculty offices, research facilities, administrative and academic support areas. In total, eight (8) buildings are included in this phase.

Phase III consists of providing services to all resident halls. The resident halls are considered to be the least important for FSU's design. In total, eleven (11) buildings are included in this phase.

Functional Requirements of Fiber

Not all fiber is created equal. The selection of fiber used in the cabling plant design is one of your major decisions. This decision will require great debate and a sound rationale for justification.

There are two major types or classifications of fiber--multi-mode and single mode. As a general rule, single mode fiber is used for long distance applications or those applications requiring an unusually high bandwidth. Multi-mode fibers are utilized for short distances covering a variety of applications. The longest distance traveled in FSU's cabling plant will be approximately 2000 feet. We are trying to build a multipurpose system over short distances, these facts lead us in the direction of multi-mode fiber.

There are three sizes of multi-mode fiber in use today--50/125 micrometer, 62.5/124 micrometer, and 85/125 micrometer. DEC recommended that FSU use 62.5/125 micrometer fiber because it is, 1) best suited for premise applications and LAN's, 2) has the best combination of attenuation and bandwidth, and, 3) is endorsed by major equipment manufacturers. Loose tube fiber-optic cable will be installed as a result of it's compacted size, isolation from outside interference, and reliability. This type of fiber is only for inter-building communications and can not be utilized inside the building because it does not meet fire codes.

The type of connectors to be installed is another

important decision. There are no officially defined standards for fiber-optic cable connectors. The ST compatible connector is probably the most widely used today. FSU has chosen the ST compatible connector for implementation. When connectors are necessary for different applications, FSU will utilize a hybrid cable with the ST compatible connector at one end and SMA 905 or etc. at the other end. This increases the flexibility of the design and standardizes the demarcation lines.

Patch panels provide an excellent control point for each building. Patch panels create flexibility for multiple uses as well as simple cable plant management by furnishing a single connect point for all applications. At this point, the application leaves the fiber-optic cable plant and makes the transition to the intra-building copper-wire technology.

The last requirement, and probably the one that will be debated the most, is the number of optical fibers in the cables. How you allocate the number of fibers depends upon the various uses and the kind of technology used for each. FSU decided on 24 fibers for each building. There are two exceptions to this policy, Fuller House and Brady Health Center. Both of these buildings are extremely small and do not warrant all applications. Therefore, these buildings will only receive 12 fibers. The distribution of fibers per applications and topology is as follows:

APPLICATION	FIBERS	TOPOLOGY
Data/Ethernet	2	Star
Voice	2	Star
Interactive Video	2	Point-to-Point
Security Video	2	Point-to-Point
Energy Management	2	Point-to-Point
ID Card System	4	Point-to-Point
FDDI	4	Ring
Redundancy and Future	6	T.B.A.
TOTAL	24	

Ethernet Configuration

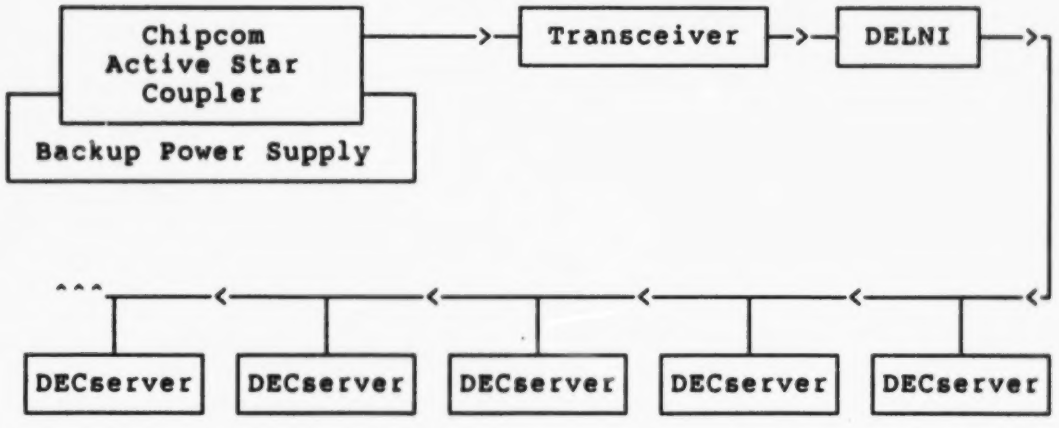
Digital Equipment Corporation is the main hardware vendor in the area of administrative and academic computing. DEC will play a major role in the implementation of the data aspects of this cabling plant design. FSU's decision to continue and expand this relationship is based on the fact

that DEC has all the necessary products and features to fulfill the institution's goals and objectives.

Each hub will be equipped with a Chipcom 9314S-ST fiber-optic ethernet 14 port active star coupler with 9300BU backup power supply. The active star coupler was choosen over the passive coupler for one basic reason, the active star coupler has additional power to boost the optical signal. This will allow for greater expansion of the network. The active star coupler will then be configured to a Chipcom 9301T-ST fiber-optic transceiver which will be connected to a Digital DELNI-BA local area network interconnect. The DELNI will support either additional DELNI's or eight Digital DSRVB-BA DECservers.

In all other buildings, the fiber-optic cable will connect to the Chipcom transceiver then right to a DELNI or DECserver depending on the number of ports necessary. Due to the easy manner in which systems may be configured, adding to the network requires no significant re-designing or disruption to users.

ETHERNET CONFIGURATION FOR HUBS



Estimated Costs

The estimated costs are the result of several different analysis. The design and management figures are based on fees which would be paid to DEC, if they were to manage the project. The fiber-optics material and labor costs are the result of DEC's original study which solicited five major fiber-optic cable installation firms. These figures are the average costs of these five vendors. The ethernet components are prices from DECdirect with the appropriate discounts.

There are some interesting issues about costs. First, labor is not cheap. It is important to balance your time with the vendor's time. The installation, assembly, and splicing can cost more than the fiber itself if you are not careful. Splicing cost varied from $35.00 per hour to $95.00 per hour depending on the vendor in DEC's study. If you are developing your first fiber-optic cabling system, it is cheaper to pay the expert at the outset than to pay for your mistakes during installation.

Second, time is money. The management of a project like this will require at least one person full-time for one year or more depending on the size and complexity of your institution. We estimated that it would be cheaper to hire DEC engineers.

Third, FSU anticipates spending an additional half-million dollars in upgrading the current administrative and academic main central processing units. This additional equipment will be necessary to deal with the expanded user environment created by the cabling plant. Time-sharing ports will grow from the present 135 to 408. These figures below are only for the fiber and related work.

Estimated Costs for All Phases

Activities	Phase I	Phase II	Phase III
Design & Management	$ 40,000	$ 17,000	$ 26,000
Fiber-Optics Material	158,000	55,000	81,000
Ethernet Components	207,568	32,332	57,662
Labor	95,000	54,000	80,000
Phase Totals	$500,568	$158,332	$244,662
Grand Total			$903,562

Implementation Timetable for other Applications

Data communications is scheduled to be the first application to be implemented. Data is expected to be on-line sometime in the spring of 1991. Data communications will consist of administrative computing, academic computing, and a new library information management system. In academic

computing, FSU supports computing for instruction, research, and faculty support services. All current and future planned microcomputer labs will be connected to the network with a file server and/or ethernet cards.

Environmental control (energy management) and campus identification card system will be implemented sometime in 1992. The energy management system will phase in approximately four to five buildings per year until completed. The campus identification card system is planning to be operational in six buildings. The system will support library access and use, a debit card system for the bookstore, dining room, snack bar purchases, and security access to computing facilities. We are exploring other aspects such as, security access to resident halls, parking, and ATM machines.

The last applications will be video and voice. The costs for a total fiber-optic PBX system and a video system for the main campus can not be justified at this time.

Some General Guidelines to Follow

- ☐ Decide early what applications need to be supported by the cabling plant.
- ☐ Choosing the appropriate design and topology is crucial. Remember any design must accommodate a variety of technologies and topologies.
- ☐ Provide enough capacity for growth. Some institutions double the capacity just for this purpose. Don't worry, you will find ways to use it.
- ☐ Time is money. Sometimes it is cheaper to pay the expert than to experiment.
- ☐ Watch your costs. Labor cost can be more than the fiber itself if you are not careful.
- ☐ Utilize mass production components and standards where ever possible. This will save money and create flexibility.
- ☐ Avoid any unnecessary hardware costs. Repeaters, for example, require maintenance and incur additional expenses.
- ☐ Use active couplers instead of passive couplers because they produce optical power and therefore allow for larger networks.

Conclusion

The development of a multipurpose fiber-optic cabling plant requires a sound planning process if all applications are to be synthesized into one coherent design. There is a consistent need to balance costs with benefit and service. Many aspects of this planning process are just plain common sense.

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